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Contents

Fertilización del Tabaco

Fertilizacion del Tabaco.

PUBLICADO POR

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Importancia de los Fertilizantes en las Vegas de Tabaco, y algunas observaciones respecto al modo más ventajoso de su aplicación al terreno.

TODO cultivador de tabaco debe tener muy en cuenta que siendo dicha planta de crecimiento rápido y exuberante, demanda gran cantidad de aquellas sustancias que contiene el terreno y que son indispensables á su nutrición. Si esas sustancias, que constituyen el alimento de la planta, y que esta ha quitado en cada cosecha, no se devuelven al terreno oportuna y acertadamente, no es posible esperar buenos resultados, ni en la calidad del producto, ni en el rendimiento promedio de las siembras.

Respecto á esto, y como ilustración práctica, tenemos el gusto de ofrecer aquí el resultado de minuciosos experimentos llevados á cabo en la Estación Experimentadora del estado de Massachusetts, y en la de Florida (Estados Unidos). La primera Estación citada está bajo la acertada dirección del Dr. Goessman, y la de Florida está á cargo del Profesor Stockbridge. Ambos han realizado un trabajo de investigación de suma utilidad para los cultivadores de

tabaco, y siendo competentes en la materia, la proporción que aconsejan para el empleo de los fertilizantes debe adoptarse sin vacilar un momento. Según, pues, la citadas investigaciones, el ácido fosfórico, el nitrógeno y la potasa, deben entrar en las proporciones siguientes, por caballeria:

	Ácido Fosfórico	Nitrógeno	Potasa
El Dr. Goessman aconseja,	1.980 lbs.	3.300 lbs.	9.910 lbs.
El Prof. Stockbridge "	2.410 "	5.950 "	9.910 "
Promedio por caballeria,	2.215 lbs.	4.630 lbs.	9.910 lbs.

Es decir, que una mezcla que contuviese como unas 19.800 libras de sulfato de potasa superior (96%), unas 28.000 libras de nitrato de soda, y unas 18.000 libras de ácido fosfato (12%) vendrían á formar las cantidades de ácido fosfórico, nitrógeno y potasa arriba indicados.

Toda vez que el análisis químico nos revela la cantidad de alimento de la planta contenida en el tabaco, esta circunstancia sirve de base para determinar, con relativa certeza, tanto *la clase* como *la cuantía* del fertilizante que debe emplearse. Y como es natural, al calcularse el alimento asimilado por la planta es necesario tener en cuenta, no solo la hoja, sino el tallo todo; pues si bien es cierto que en la hoja se cifra todo el interés, esta no puede crecer sin el tronco, raíces, etc. La planta, en conjunto, ha sido analizada por el Profesor Stockbridge, en la Estación Experimentadora de Florida, con el resultado promedio siguiente:

Ácido fosfórico, 0.99 por ciento; Nitrógeno, 2.58 por ciento; Potasa, 4.34 por ciento, contenido en dicha planta.

Esto nos indica que la siembra requiere para su nutrición, y que realmente se asimila, una proporción de 260 libras de nitrógeno y 440 de potasa por cada 100 de ácido fosfórico. Y como este último componente suele cambiarse en formas insolubles al incorporarse al terreno, bueno es tener eso presente y compensarlo al preparar ciertos fertilizantes especiales. En cambio, sucede á veces, que el cultivo alternado de las leguminosas acumula el nitrógeno en el suelo, en cuyo caso, si el empleo del nitrógeno en el fertilizante se prodigase algo, podría producir tal exuberancia en la hoja que más bien sería en detrimento de su calidad. Débese á esto el que muchos cultivadores de tabaco de reconocida experiencia empleen mayor proporción de ácido fosfórico, y menor de nitrógeno, que la que podría deducirse como indicada por la composición química de la citada siembra.

Todo esto lo ha tenido en consideración el Profesor Stockbridge al recomendar su fórmula para el empleo de los fertilizantes, porque con dicha fórmula se reponen las sustancias nutritivas (según previos análisis) que una cosecha normal de tabaco necesita asimilarse de cada caballeria de tierra sembrada de tabaco.

El resúmen de autoridades reconocidas acerca de este asunto puede expresarse en la forma siguiente:

Las siembras de tabaco reclaman el ácido fosfórico en pequeña proporción, mayor la de nitrógeno, y en proporción mucho más grande la potasa: de esta última, en rigor, en cantidad mucho más crecida que ninguna otra planta de cultivo.

Una buena práctica en el cultivo inteligente del tabaco aconseja la proporción siguiente: Nitrógeno de 4 á 6 partes: Potasa de 8 á 15 y de 1 á 3 de Ácido fosfórico.

Ó para decirlo en forma más concisa:

Amoniaco, de 4 á 5 por ciento.
Potasa, de 8 á 9 "
Ácido fosfórico aprovechable, de 2 á 4 por ciento.

Es muy importante recordar siempre que el valor de los fertilizantes del comercio es relativo, porque ha de ser en *relación directa* del nitrógeno, la potasa, y el ácido fosfórico aprovechable que contengan y siempre que se apliquen dichos ingredientes en su *debida proporción*. Y téngase presente que si hay exceso en la cantidad que se aplique de uno de estos tres componentes del alimento de la planta, el daño que resulte no se subsana por la falta de cualquiera de los otros en el fertilizante: la proporción de los tres es esencialísima, como lo es también, para obtener el mejor resultado, el origen de dichos ingredientes. Por ejemplo; Potasa: debe escogerse siempre el "sulfato de potasa," y aun mucho mejor si es de calidad conocida por "sulfato de potasa de 96%." Otras formas, tales como el muriato de potasa, y Kainit (que contienen gran cantidad de clorino) no deben aplicarse nunca al tabaco, toda vez que su influencia es nociva para la hoja, resultando "mal ardedora."

Para producir un fertilizante de la proporción ántes indicada, es decir, que contenga 5% de amoniaco, 9% de potasa, y 4% de ácido fosfórico aprovechable, los siguientes componentes deben entrar en una tonelada:

TABACO SIN FERTILIZAR. FINCA DE EXPERIMENTOS "SOUTHERN PINES," CAROLINA DEL NORTE.

TABACO, FERTILIZADO CON POTASA, ÁCIDO FOSFÓRICO Y NITRÓGENO (FERTILIZADOR COMPLETO) FINCA DE EXPERIMENTOS "SOUTHERN PINES," CAROLINA DEL NORTE.

Pulpa de Semilla de algodón,	1100 libras.	
Sulfato de potasa (96%) .	350	"
Ácido fosfato	550	"
Total, .	2000 libras.	

¿ Y qué cantidad de la anterior composición debe aplicarse á una extensión dada de terreno? No es posible prefijar dicha cantidad, que naturalmente varia segun el país donde se aplique. No obstante, puede decirse que de 33 mil libras á 49 mil, por caballeria, aseguran un resultado ventajoso. Los cultivadores de tabaco del estado de Connecticut, usan, por lo general, hasta 99 mil libras por caballeria. La cifra de Connecticut no debe seguirse escrupulosamente en un país como Cuba, por ejemplo, donde es proverbial la riqueza de sus vegas de tabaco; pero sí puede servir *de base* para los experimentos particulares de los cultivadores, que si se llevan á cabo con inteligencia, muy pronto podrán averiguar la cantidad de fertilizantes de la proporción indicada que ha de darles el mayor beneficio, tanto en el rendimiento de la cosecha, como en la calidad del producto. No hay inversión de dinero más acertada que aquella destinada á abonar la tierra, no solo porque asi recupera sus elementos de riqueza natural, empobrecidos por el cultivo, sinó también porque siempre que la fertilización se haga en la debida forma *y con los fertilizantes adecuados*, el resultado superará con creces la loable ambición del agricultor.

Componentes de las sustancias fertilizantes que se emplean para obtener nitrógeno. También su proporción.

	Nit.	Equivalente en Amoniaco.	Potasa (K_2O.)	Acido fosfórico Total.
Nitrato de soda............	15 á 16	18 á 19½	......	....
Sulfato de amoniaco.......	19 á 22	23 á 26	......	....
Sangre seca (Superior).....	12 á 14½	14½ á 17½	......	....
Sangre seca (Inferior)......	10 á 11	12 á 14½	......	3 á 5
Resíduos concentrados de tanques (fondajes).	11 á 12⅞	13½ á 15	......	1 á 2
Fondajes....	5 á 6	6 á 7½	......	11 á 14
Fondajes.................	7½ á 9	9 á 11	......	8½ á 10½
Resíduos de pescado seco...	9½ á 11	11½ á 13½	....	6 á 8
Pulpa de semilla de algodón	6½ á 7½	8 á 9	1½%	2%
Pulpa de castor............	5 á 6	6 á 7	1%	2%
Palillos de tabaco..........	2 á 3	2½ á 4	5 á 8	Como 1%

Idem Idem para obtener el ácido fosfórico.

	Aprovechable.	Insoluble.
Roca fosfórica de Carolina del Sur......	....	26 á 27
Fosfatos ácidos de Idem................	12½ á 15	1 á 3
Fosfatos de guijarros de Florida........	....	26 á 32
Fosfatos ácidos de Idem................	15 á 17	1 á 3
Fosfatos de Tenesí.....................	....	34 á 39
Fosfatos ácidos de Idem......	14 á 19	1 á 3
Hueso calcinado (vivo).....	....	32 á 35
Hueso calcinado (disuelto).............	15 á 18	1 á 2
Hueso calcinado (pulverizado)..........	5 á 8	15 á 17
Guano del Perú........................	 8	2 á 7

Componentes de las sustancias fertilizantes que se emplean para obtener la potasa.

	Potasa para (K_2O.) tanto por ciento.	Cal, tanto por ciento.	Amonia, t. p. c.	Clorino, t. p. c.
Muriato de potasa..........	50	....	....	45 á 48
Sulfato de potasa (Superior)	50 á 55	....	....	0.3 á 1.5
Sulfato de potasa-magnesia.	27 á 30	0.85	....	1.5 á 2.5
Carbonato de id. id.	18½	....	....	....
Kainit..........	12½	1.12	....	30 á 32
Sylivinit..................	16 á 20	....	....	42 á 46
Cenizas de semilla de algodón	20 á 30	10.	....	....
Nitrato de potasa ó salpetre.	43 á 45	....	16 á 17	....
Cenizas de madera (vivas)..	2 á 8	30 á 35	....	....
Cenizas de madera (lejías)..	1 á 2	35 á 40	....	....
Palillos de tabaco..........	5 á 8	3.5	2½ á 3½	....

Tipos promedios de la composición de los abonos orgánicos, tales como de establo, etc.

	Nitrógeno.	Equivalente en Amoniaco.	Pota.	Cal.
Estiércol de vaca (fresco)...	0.34	0.41	0.40	0.31
Id. de caballo (fresco)	0.58	0.70	0.53	0.21
Id. de carnero (id.)	0.83	1.00	0.67	0.33
Id. de cerdo (id.)	0.45	0.54	0.60	0.08
Id. de gallina (id.)	0.63	1.98	0.85	0.24
Abonos mezclados de establo, (pen) abonos de corral etc.....................	0.50	0.60	0.63	0.70

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ORANGE CULTURE

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INTRODUCTION.

THE orange is as staple as the apple. It is the standard dessert fruit of America. The demand for it is constant and always increasing. To meet this demand the business of orange growing has reached enormous proportions, and has become the leading industry of large sections. California and Florida are, and doubtless will remain, the two most important centers of orange production. Other States and territories, however, are becoming recognized factors in the production of this fruit. Alabama, Louisiana, Texas and Arizona possess commercial groves which are being increased.

The present crop of California may be safely placed at 13,000,000 boxes. The Florida crop for the season of 1903 was approximately 2,000,000 boxes. This is hardly one half of the estimated crop for the year 1894, when the Florida groves were so nearly ruined by the "great freeze." Groves are rapidly increasing in the State, so that the crop has almost reached its pristine importance. The annual crop of the country now represents about 18,000,000 of dollars to the growers.

Entirely aside from the commercial importance of the industry and the profits offered by the business, orange growing possesses fascinations making the occupation well nigh irresistible to those once subjected to its magic in-

fluence. Succeeding only in regions with climatic conditions nearly ideal for health and pleasure, with a harvest time when most other fruits and plants are in their unattractive period of rest, with the glistening dark green foliage contrasted with golden fruit, with the mild warmth of winter sunshine, with bloom of flowers and song of birds to add to the enchantment, with long periods of comparative leisure between the seasons of chief activity, with a staple product and ever growing demand, the orange grower is confronted by as few vicissitudes and as many pleasures as fall to the lot of the producers of any natural product.

Although the business demands a high degree of skill, intelligence and professional ability of those engaged in it, any one who is able to give the study and care to a general business necessary to success, can successfully grow oranges. There is a constant accession of new growers, seeking the rewards and health offered by the orange grove.

It is the object of this little work to place at the disposal of the experienced and inexperienced alike, the best and latest developments of successful practice. Its endeavor is to make available in simple form, the established facts and principles, on whose application the success of the business must depend.

ADAPTATIONS.

Climate. The climatic adaptations of the orange tree are more important, as they are more definitely defined than are its relations to soil or other conditions. In both California and Florida, it is found growing on soils widely different in compostion and properties.

Being a semi-tropical product its climatic restrictions are chiefly those of temperature. Its degree of hardiness varies materially with varieties. Condition of he tree at the time it is subjected to cold exerts great influence on its resistant power. The minimum normal temperature of any locality, is the first and most important point in determining its adaptation to orange culture. The tree when dormant, may be safely subjected to a temperature of 20 degrees. Under favorable conditions, particularly cloudy weather following the cold, a temperature of 14 degrees above zero, for a few hours, results in no serious harm to trees. Either of these temperatures would inevitably be followed by defoliation. Neither elevation nor latitude controls these conditions, since temperature is often influenced by purely local conditions, especially those modifying or directing air currents.

Sufficiency of water supply is the other important climatic consideration in locating orange groves. Being an evergreen, its demand for water is continuous, since exha-

lation from the leaves goes on even while the tree is dormant, though not to the same extent as during the growing season. Nature makes the important suggestion of placing her wild groves only on moist hammock soils. Though the orange was first found growing on low, moist soil, there is no tree that will grow and do well on a greater variety of soil. There are orange groves planted on land so low that it is necessary to place the trees on a ridge to keep the roots from being in standing water and give ample drainage; there are other groves located on high pine land where water in the wells stands at twenty feet from the surface and still others in sections where rains are practically unknown. The tap root of the orange tree enables it to seek and find water at a considerable depth, but where there is not an adequate rainfall, irrigation must be made to supply the natural deficiency.

In California artificial watering is depended on exclusively. In Florida, where the rain-fall is seldom less than 50 inches, spray irrigation is sometimes provided as insurance against damage from drought, oftentimes serious just after the young fruit sets.

Soil. Though in most orange growing sections, the term "Orange Soil" is in common use, it will be found that in even limited localities the name is not applied to any particular soil, possessing distinct properties. Orange soils may be accepted as including any good arable soil free from standing water, and possessing responsiveness to cultivation and fertilizing. In Florida such soils include the

great variation between the sandy pine ridges, the retentive "hammocks" and the nearly solid porous-limestones of the East Coast. In California such extremes as the gray gravel of the foot hills and the alluvium of the river bottoms seem equally adapted to the orange, when the trees are provided with the other requisites to normal development.

The character of the root system of the orange gives an important suggestion as to its soil adaptations. This tap-root is of a very distinct character. It will not survive standing water, nor exist in either natural or artificial hard-pan. Soils possessing either of these conditions, should be excluded from consideration as sites for groves.

PROPAGATION.

Seedlings. The orange is not indigenous to the American continent. Wild trees of two distinct species, the Citrus aurentum and the C. vulgaris, respectively, the sweet and sour orange, have grown wild in Florida ever since the first English speaking settlers became familiar with the country. They were, however, both introduced by early Spanish explorers. Finding all their requirements supplied by nature, they throve for several centuries as wild occupants of the land.

The sour orange is so nearly worthless, as to remain commercially unimportant. The sweet seedling constituted most of the early groves which gave Florida fame as an orange producer. Most of the groves of to-day are the

result of perpetuating a distinct type or quality of seedling, by budding it on a root or stock of different origin and unlike properties.

The seedling orange, like the peach or other fruit, does not perpetuate its own qualities in the next generation. The fruit of a tree need not resemble the fruit producing the seed from which the tree grows. The planting of seed, therefore, merely assures a tree, but offers no basis for foretelling the character of its fruit. A few seedling trees produce fruit as good, or better, than that from which the seed came. Desirable fruits originating in this way are perpetuated by budding or grafting. That is, by transferring growing buds of the tree desired, to the growing wood of the tree whose product is to be thus changed.

Stocks. These are the trees, usually the entire roots of young trees, to which the growing buds of the kind desired are transferred. The result is a tree producing fruit with the properties of the tree from which the bud was taken. Although the fruit follows the character of the bud, the tree itself is very materially influenced by the nature of the stock on which it grows. This influence is particularly noticed in the matter of hardiness, and resistance to cold. The C. trifoliata stock greatly increases the cold-resisting power of the tree budded on it. The C. vulgaris used as stock for budded trees renders them comparatively immune to the *mal de goma*, gum disease, so serious in some orange sections.

It is particularly worthy of note that the budded tree

develops and retains the root system of the stock used. Stocks, or different species of orange trees, vary greatly in the nature of their root system.

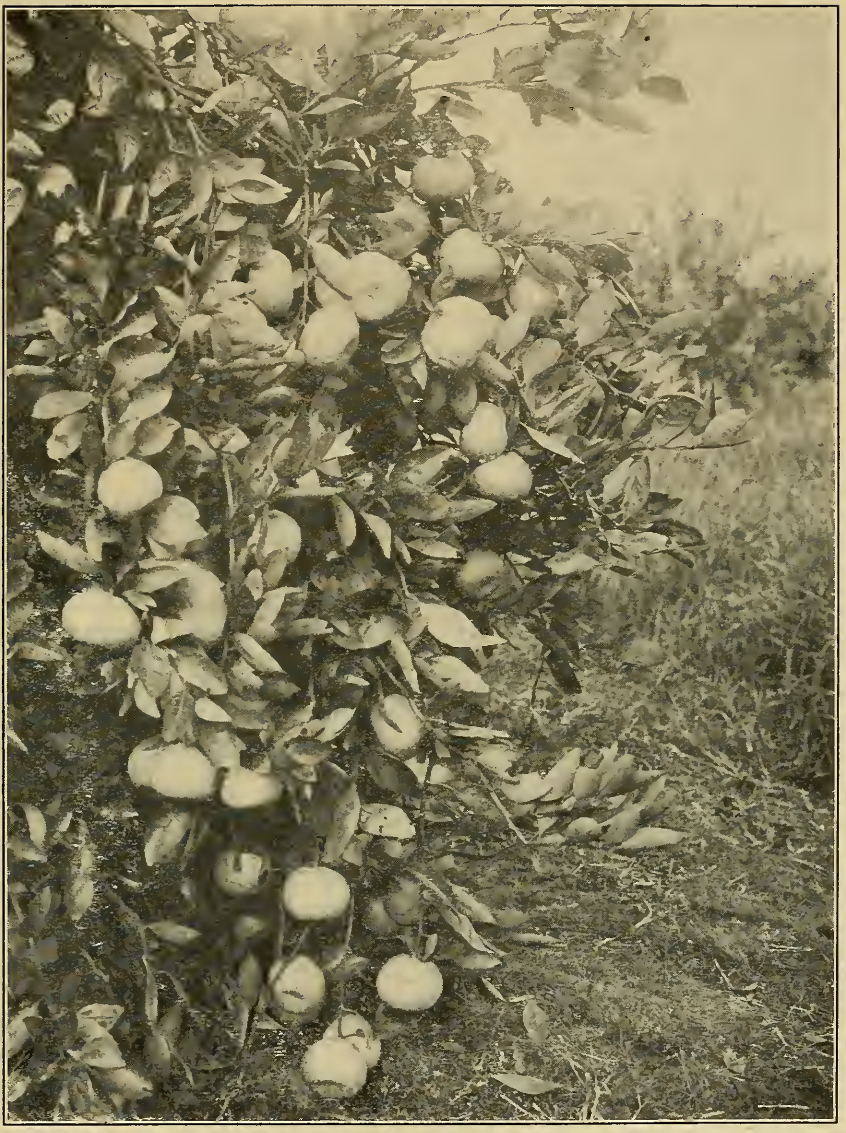
The sour orange is particularly deep rooted. The sweet orange is surface rooted and its feeding roots seem to develop at the expense of the tap-root. The pomelo furnishes a stock with some of the advantages of the sweet orange, but with a root system closely resembling that of the sour stock. The natural inference is, that for dry localities, or where the natural water supply is deep, the sour stock possesses advantages offered by neither of the others. The Florida rough lemon, with its early maturity and rank growth, furnishes a stock particularly adapted to frostless localities.

Budding. This is a form of grafting in which a single bud is inserted in the cleft bark of the tree used as a stock, instead of a cion being inserted in the sap-wood of the tree, as with the regular graft. The character of the orange wood makes budding the nearly invariable practice. The fruit of the tree thus produced is true to the type from which the bud came. The other characteristics of the tree follow the nature of the stock used. Budding is best performed when the sap is in full flow. The buds should be entirely dormant.

Hybridizing. Several of the standard varieties of oranges doubtless originated by the natural cross-fertilization of quite distinct types, which have been preserved for commercial purposes by budding. The importance and

possibilities of producing new orange types by the artificial fertilizing of the flowers of different species, resulting in true artificial hybrid trees, possessing some of the desirable traits of both parents, has recently attracted great attention. Professors Webber and Swingle of the United States Department of Agriculture have succeeded in crossing the sweet orange C. trifoliata, with the inedible deciduous orange of Japan, which is hardy as far north as Pennsylvania. The result has already been the production of several edible fruits with hardiness greatly exceeding that of any edible orange. One of these, the Tangelo, bids fair to achieve prominence as a substitute for lemons and limes, productive far north of any region of orange culture.

The object in view in this line of effort, has been the development of an orange of commercial value, with the pronounced hardiness of the deciduous parent. Results already achieved indicate that this object is quite within the range of possibility, and that hybridizing must hereafter be recognized as an accepted method of orange propagation.



SATSUMA ORANGES FROM FLORIDA.

RESULTS FROM GOOD CULTURE AND LIBERAL FERTILIZATION.

VARIETIES.

Types, To the novice in orange culture, or to persons whose interest in the fruit is confined to the specimens found in market, and whose knowledge of distinctions would be expressed in the terms good, better, best, it is surprising to learn that there are about as many varieties of the orange as there are of the apple. It is nevertheless true, that the number of described varieties reaches scores, and that nearly every well equipped nurseryman in orange growing sections, regularly propagates two dozen or more different varieties.

These varieties differ in many of the most essential characteristics. Size, flavor, sweetness, beauty, number of seeds, hardiness, productiveness, period of bearing and season of fruiting and adaptation to localities are the chief distinguishing features.

It is impossible here to even name the different accepted varieties. There are several recognized types, from which one or more representative varieties may be selected as characteristic of the numerous oranges belonging to the type, as follows:

Seedlings: Florida, Sweet Seedling, Tahiti, Homosassa.

Modified Seedlings: Joppa, Wolfskill's Best.

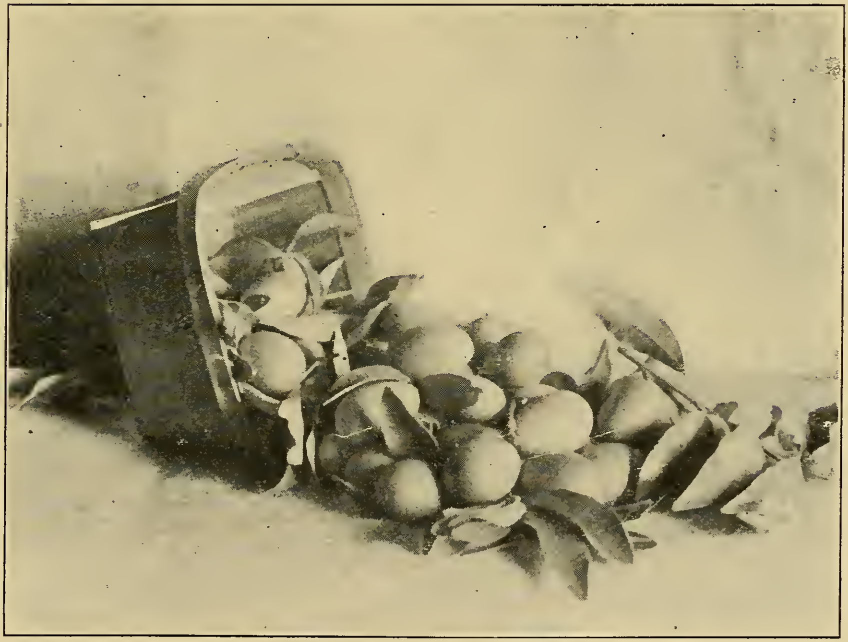
Navels: Washington, Rivers'.

St. Michaels: Paper Rind, Hart's Tardif, Valentia Late.

Blood Orange: St. Michael's Blood, Maltese, Ruby.

Mandarin: Satsuma, Dancy, King.

Among the more valuable of the characteristics of the different varieties, is the difference in season for ripening. By means of this distinction, it is possible to select varieties which will extend the orange season from September to June. Any good nursery catalogue gives the date of the ripening of standard varieties.



KUMQUATS FROM FLORIDA.

PREPARATION FOR PLANTING.

Localities differ so greatly in their relations to tree development that the treatment of the site selected for the grove, previous to setting the trees, must be determined by local conditions. There are, however, certain general principles which apply to all localities.

Thorough plowing and pulverizing of the land to be devoted to the grove should be insisted on. Even newly cleared hammock and the South Florida rock land should not be exempt from this injunction. The habitat of the tree is never restricted by a small circle immediately around the trunk. It is eventually to occupy, and feed from the entire area. The entire soil must therefore eventually be worked, if the best results are to be secured. This can never be so effectually and economically accomplished as before the trees are in place. The character of the soil must determine the depth of the breaking, but one foot is seldom too deep.

This first working should be accomplished during the Fall or Winter preceding the planting. Vegetation will thus have a chance to decompose and leave a mellow bed for the roots of the young trees. Where irrigation is to be practised, the land should be carefully graded, so that all parts may be reached by the water, and the accumulation of pools be prevented.

Should the soil be somewhat subject to excessive moist-ure, as is the case with some hammock and "glade" lands

in Florida, the land should be thrown into beds as wide as the distance between the intended rows of trees, which should then be planted in the centre of the beds. The water-furrows will then be half way between the rows, which should run in the direction of the natural slope or drainage of the land.

The land should be susceptible to the thorough cultivation of the hoed crop. All obstacles to such treatment should be removed. There is no more excuse for stumps and rocks in a grove than in a garden. Not that clean culture must always be followed, but that perfect control of conditions, and full protection of trees, are not possible when obstacles to perfect cultivation exist.

TRANSPLANTING.

Time. The orange being an evergreen, may be transplanted through a very much longer period than is the case with deciduous trees. Indeed it may be set out at any time without serious risk, but there are naturally certain seasons when transplanting may be performed with best results.

Citrus trees have several periods of comparative dormancy. These vary in different sections. As a rule the time immediately preceding full activity, the natural blooming season, is best for this purpose. Late winter and very early spring is the favorite planting time in Florida. Early summer is the preferred time in California.

Age. This will be modified by variety and location. The stock used also has an important bearing on the question of age for transplanting.

Seedlings grow more slowly than budded trees, and should have the advantage of a year at the time of setting out. The trifoliata stocks are usually transplanted as one year old buds. Other varieties should remain at least two years in the nursery row.

Methods. The orange grower will, as a rule, find it best to depend on the professional nurseryman for his supply of young trees.

Most trees brought considerable distances will be received with bare roots, the tap-root being cut about one foot long. At least one half of the foliage should be re-

moved. The clipping off of a part of each leaf is preferable to removing one half of the entire number of leaves.

Great care should be taken to prevent the roots of the trees from being exposed to the sun for any length of time during the transplanting process.

Holes should be dug large enough to receive the roots without cramping. The hole should be partly filled with fine earth as a bed for the roots. In this bed a hole for receiving the tap-root should be made with shovel handle. The tree should be set a little higher than it grew in the nursery, to allow of settling. The soil should be carefully settled around the roots by hand. When the hole is nearly filled, the ground should be thoroughly soaked with water, that the roots may immediately find moisture, the soil be closely pressed to the roots, and all air holes filled. The hole should then be filled in, a little higher than the surrounding level. Sprinkling the foliage after the tree is set, is a great advantage, as evaporation from the leaves is thus checked and wilting and shock are proportionately reduced. A quicker start is thus secured.

Laying out the grove, as well as distance of trees apart, must depend largely on varieties. Location and character of soil will also have important bearing on this point.

The most frequent system of planting is in squares. The quincunx system with a tree in the center of each square has its adaptations. This is usually followed when the permanent grove consists of large and slow growing sorts, like the sweet seedling, then the center of the square

may profitably be occupied by a quick growing smaller tree, like those of the Mandarin type, which may be removed when the large trees reach full size. The hexagonal and other systems allowing of more trees per acre, are not generally used.

The distances at which trees should be placed, should be greater on hammock and very productive soils, than on sandy and less fertile ones. The size of trees varies so much with variety, that this must remain the controlling factor in deciding the matter of distances.

For common stocks 25 to 30 feet each way are the standard distances. Trifoliata and pomelo stocks should be set 18 to 20 feet apart. At 20 feet each way an acre accommodates 108 trees. The number required for the square system is easily calculated for any distance. The quincunx system requires 15 per cent more trees than the square, for the same distances.

CULTIVATION.

Time. No hard and fast rule can be laid down for the cultivation of the grove, except that experience in all countries leads to the conclusion that orange trees should be treated as a cultivated crop, and be given careful thorough tillage during some part of each year.

SHOWING CLEAN CULTURE IN GROVE—WELL FERTILIZED.

Cultivation unquestionably stimulates root activity. It has, therefore become an accepted belief, that during the periods of dormancy of the tree, occurring in different sections at somewhat different seasons, cultivation should cease, that the natural recuperative rest of the tree may not be interfered with.

There is another reason why this period, existing chiefly in the winter, should not be disturbed, in sections subject

to damage from cold. Cultivation starts root action. Root action brings the sap into flow. The more near perfectly dormant the tree is, when subjected to cold, the less the danger of injury. During the period of liability to serious cold, therefore, all working of the soil, with its stimulating effect on the roots, should be wholly abandoned. It may be accepted as a safe rule that cultivation should be confined to the interval, between February and November. During this period, however, practice in different sections varies greatly. In California the accepted rule is — "the soil must be kept mellow and free from weeds at all times." It is another accepted practice to cultivate after each irrigation.

In Florida a quite radical difference in practice has become general. During the heat of summer cultivation ceases. For three months not only are the plow and cultivator kept from the grove, but the tendency of nature to cover the unprotected soil from the burning heat of the sun, by means of protecting vegetation, is encouraged.

The Florida orange grower is, year by year, going farther in this direction and now even sows protective forage crops, chiefly legumes, particularly desmodium and velvet beans, as a nitrogen-conserving method for preventing the burning up of the organic matter of his soils by the heat of mid-summer. These crops are either harvested or plowed under in the Autumn, thus increasing the fertility and tree-sustaining capacity of the soil.

Clean Culture vs. Cover Crops. This comparison has been thoroughly made in both Florida and California.

The victory, and general practice is in favor of the cover crop, on all soils free from excess of organic nitrogenous matter and where die-back has not manifested itself.

Methods. The character of the soil will necessarily chiefly influence the nature of the cultivation followed, and the means by which it is effected. On the comparatively light soils of Florida cultivation from 4 to 6 inches deep is the common practice. The plow is used for this purpose usually at least once per year. The more frequent cultivations are accomplished by use of the orchard cultivator, a cut-away, or the spading harrow. In dry seasons the more frequent and shallow cultivation is practiced.

In California the subsoil plow was formerly believed indispensable, to break up the "irrigation hard-pan" resulting from constant plowing and watering to a fixed depth. The effects of the root destruction inevitable to the use of the sub-soiler, became so apparent that the practice is no longer commended. Plowing to the depth of one foot in three furrows between the rows, and plenty of water slowly and continuously used, effectually overcome the hard-pan, or prevent its occurrence. Although not now needed as much as formerly the regular and deep use of the chisel-toothed cultivator, together with plenty of water used slowly are equally effective. (*)

(*) California Ex. Station Bulletin 138,

FERTILIZING.

The orange is more dependent on quality for liberal returns to the grower than is any other fruit. This is necessarily so from the fact that it is almost exclusively a dessert fruit consumed in its natural condition. It is seldom converted into secondary products, is rarely cooked and therefore its natural properties are neither supplemented, changed nor corrected by art or artifice. The orange is also extremely susceptible to modification through the influence of the food upon which it feeds. These facts make the matter of fertilizing the tree one of the most important factors involved in orange culture.

This is true wherever the business has reached a high state of development. Wherever an assemblage of orange growers begins discussing any phase of the business in which they are engaged, the problems of satisfactory fertilizing are sure to come to the front. The groves may slope to the shores of the Mediterranean, bask in the sunshine of the Pacific or be kissed by the breezes of the Gulf of Mexico, but the golden fruit they bear has resulted from the practice of the advanced science of plant fertilizing.

In Florida the larger proportion of the groves are located on pine land so deficient in general fertility, that whatever is taken from the soil in the form of crop, must have first been artificially given to it in the form of plant

ORANGE EXPERIMENT OF MR. JOAQUIN BERNAT, CATARROJA, SPAIN.

TREE FERTILIZED WITH POTASH, PHOSPHORIC ACID AND NITROGEN. YIELD PER ACRE, 1706.7 LBS.

TREE FERTILIZED WITH PHOSPHORIC ACID AND NITROGEN. NO POTASH. YIELD PER ACRE, 1330.5 LBS.

food. In California many groves are planted on land shown by analysis to be strong in all the essentials of plant growth. Yet on these lands, with regular irrigation, successful growers "do not consider it prudent to make too great de-

ORANGE GROVE NEAR RIVERSIDE, CAL., SHOWING LACK OF FERTILIZATION.

ORANGE GROVE NEAR RIVERSIDE, CAL., LIBERALLY FERTILIZED WITH COMPLETE FERTILIZER.

mands upon the soil without giving back some equivalent in the form of plant food." (*)

This unity of opinion and similarity of practice, in sections so far apart and different in natural conditions, is the strongest proof of the necessity and importance of orange grove fertilizing.

(*) "Citrus Culture in California" p. 134.

The basis of practice. Whatever may be the local modifications, the accepted basis, the accepted starting point for the rational fertilizing of any crop, is the chemical composition of that crop.

The object of the intelligent cultivator is to apply to the soil the plant food required by the crop to be produced thereby, and which experience shows that the crop is unable to secure by natural means. A knowledge of the character and habits of growth of the crop in question, and of the composition and properties of the soil, are important modifying and accessory considerations.

Each of these factors must be separately considered in reference to orange production.

Composition of Oranges. The fruit of California and Florida differs each from the other so greatly in character and composition, that analyses of both are here presented.

FERTILIZING CONSTITUENTS IN 1000 LBS. OF ORANGES. (*)

	Phosphoric Acid.	Nitrogen.	Potash.
California.....	0.53 lbs.	1 83 lbs.	2.11 lbs.
Florida........	0.77 "	1.24 "	4.79 "

The comparison of these figures shows a very noteworthy difference in the composition of the fruit of the two States. It is probable that this difference in the fertilizing consti-

(*) Cal. & Fla. Sta. Bulletins, respectively Nos. 88 and 17.

tuents of the fruit of the two sections is in keeping with the well known differences in the character of the fruit itself.

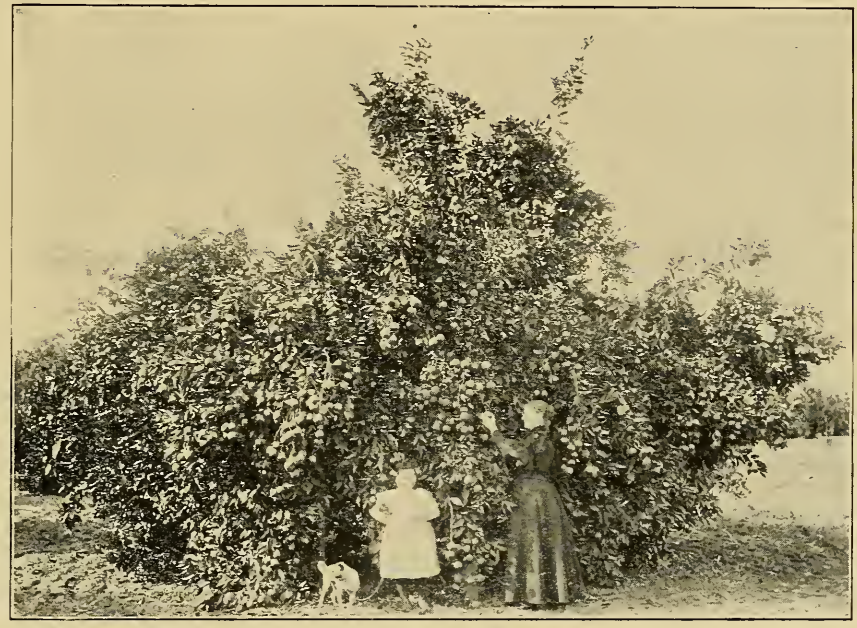
The most noticeable difference is in the potash content. The Florida fruit contains more than double the amount found in that of California. The well recognized influence of potash on sweetness and flavor would, with these analyses in hand, seem to explain the pre-eminence of the Florida fruit in sweetness and flavor.

Composition of Orange soil. The composition of any soil, as determined by analysis, has little bearing on methods of practical fertilizing. This must be true, from the impossibility of determining the amount of any soil constituent which may really become available, or possibly used by any crop during its period of growth. The chemical composition of the soil is now generally believed to be of less importance to the plant than the physical condition of the soil and its constituents. The composition of the soil, however, does offer some indication of its crop adaptations and general productivness.

The futility of soil analysis as a basis for fertilizer treatment is forcibly illustrated by experiments made in California on soil shown by analysis to contain available potash "sufficient for many consecutive crops, but on which the application of potash increased the yield of fruit, improved the growth of the trees and raised the sugar content of the juice over 37 per cent." (*)

(*) Prof. Woodbridge, Report Riverside Hort. Club.. 1895.

The Food Requirements of the orange differ from recognized requirements of other crops, only in amount and proportions. Potash, phosphoric acid and nitrogen are demanded by the tree, in excess of the ability of common



GROVE OF A. M. SEELEY.—COVINA, CAL.
SHOWING RESULTS OF COMPLETE FERTILIZER—POTASH, PHOSPHORIC ACID AND NITROGEN.

soils to supply, and must therefore be provided by the grower. His concern is not what but how much and in what form to apply.

It should be here noted that lime is known to possess special adaptations to the orange. Its action is to produce the desirable thinness of skin. Since all commercial forms

of phosphate supply available lime, its artificial providing is seldom required.

The special properties and adaptations of each of the three plant food essentials must be separately considered, so that the principles controlling their successful use may be understood.

Phosphoric Acid. Its direct effect is exerted more on the tree than on the fruit. The seed, however, makes considerable demands for it. Lack of sufficient supply of this material, is frequently manifested by a mottled or slightly variegated appearance of the newly formed leaf. The disappearance of this condition, upon the liberal application of phosphatic fertilizers, is probably in part due to the well known action of phosphates, which are always accompanied by sulphate of lime, if acidulated, in liberating otherwise unavailable plant food. The demand of the orange for this material, is really considerably less than for either of the other two essentials. There can be no doubt that most complete, ready mixed fertilizers, supply much larger quantities than are needed, or can be ecomonically applied.

Nitrogen. The special offices of nitrogen in orange production, are to force vigorous, even rank, growth. This is manifested in wood, leaf and fruit. The effect on foliage is most noticeable. Absence of sufficient nitrogen manifests itself in paleness or yellowness of leaf, scanty foliage and apparent lack of vigor. Abundance of nitrogen results in luxuriant growth. abundant, glossy and dark colored leaves. Heavy juicy fruit is another result of abundant

nitrogen supply. Dry, light, fruit, with superabundance of "rag" is an indication of lack of nitrogen. Excess of nitrogen is followed by rankness of growth, succeeded by death of the ends of the twigs, recognized as the insipient stage of "die-back" which is a sure indication of malnutrition. The fruit becomes thick and rough skinned.

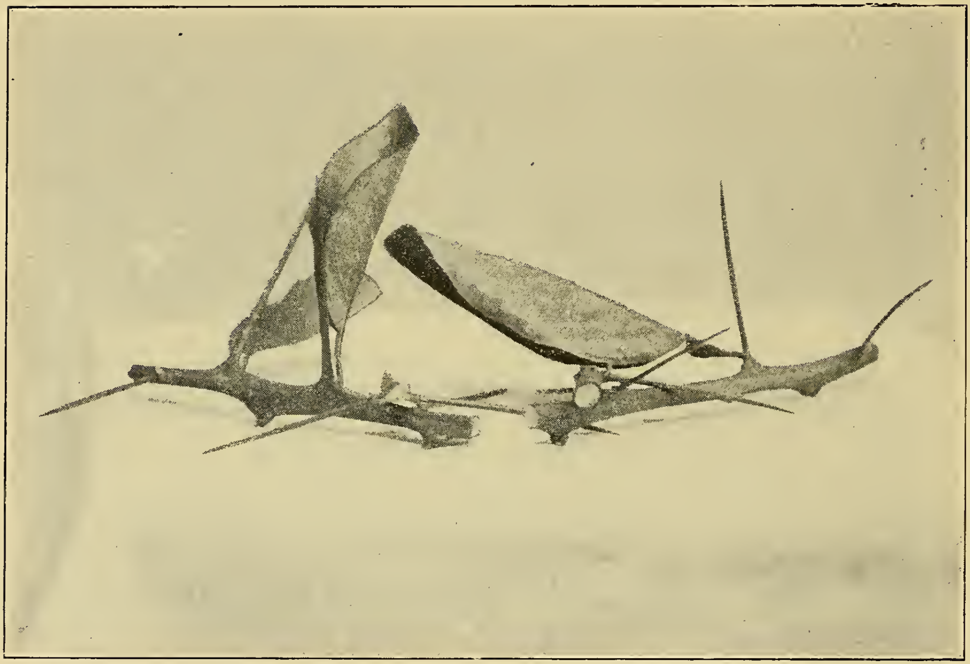
Potash. This exerts a very apparent influence on the general vigor of the tree, and its productiveness. Its most decisive influence is on the character, color, sweetness and flavor of the fruit, and on the ripening, or hardening of the wood. Lack of potash is manifest in the preponderance of immature wood and the consequent susceptibility of the tree to injury from cold.

Over one half of the total ash of the fruit consists of potash. Scientific experiments both in California and Florida as well as the consensus of opinion among the most observant growers, leave no room for doubting the direct influence of potash on the quality of fruit, especially on its sweetness.

The influence of potash on wood development is, in some respects apparently greater with the orange than with other trees, and in this particular has a special significance so far as the health of the tree is concerned.

The new growth of orange wood is normally not cylindrical; the young twigs are at first flattened on two or more sides to an angular form, usually approaching a distinctly three sided or triangular condition. Toward the end of the first season this condition usually disappears, if

normal development proceeds. It is observed, however, that in case of over ammoniating of the trees this angular condition is much more persistent, and the development of round branches is delayed. In groves deficient in potash, or showing excess of ammonia fertilizing, branches two



SHOWING EFFECT OF POTASH ON TWIG DEVELOPMENT.
No POTASH—FLAT AND SHARPLY CORNERED. POTASH -ROUND AND WELL DEVELOPED.

years old showing three, four or even five well defined flattened sides are much in evidence. Where this condition exists the liberal use of mineral fertilizers, especially potash conteracts this condition.

Not only does this condition of the young growth of a tree, therefore, give good indication of its fertilizer re-

quirements, but the fact is of particular importance in its relation to tree health. Over ammoniation is recognized as one of the chief causes of die-back. Careful observation shows that, even with twigs of the same age, die-back is most prevalent where the proportion of angular twigs is greatest. The persistent presence of this condition of the young branches, after the first year, is a sign of more or less abnormal development, due to unnatural conditions. The changes are among the pre-disposing causes of one of the most persistent orange tree diseases, die-back. Potash seems to be a corrective of these conditions, and its liberal use lessens the probability for disease and improves the condition of effected trees.

Relation of Habits of Growth. With the special relations of the different plant foods of the orange in mind, the modifying effects of the character of the tree on the practical application of fertilizers, must be considered, before discussing the important matter of the forms of supply.

There are three facts relative to the habits of growth of the tree, which have direct bearing on the matter of practical fertilizing

First is the fact of the great longevity of the tree itself. This age and slow development means that any fertilizer applied to the tree, unless interfered with by other conditions, is subject not only to the action of the tree, but of the elements, and soil changes for a long time. The result is that material not used by the tree during the first season, may become available the next, or possibly remain for years

within reach, and eventually be used. The special significance of this fact, lies in its application to the phosphoric acid. The reverted acid is probably fully as valuable to the orange, as the soluble form, and doubtless in time becomes available and is used by the tree. This accounts for the common preference of growers for bone-meal and similar forms of phosphates.

The next important consideration in connection with the character of the tree or its habits of growth, concerns its root system.

Different types of oranges or different stocks, possess root systems quite different in their relations to the matter of the plant food supply adapted to their requirements.

The sour stock is much more deeply rooted than is either of the others. Nitrification is a comparatively shallow soil process. The shallow rooted stocks are therefore more likely to derive full benefit from the fertilizers whose nitrogen must undergo the nitrification process. On the other hand, sour stocks are most likely to utilize nitrates, which often penetrate the soil below the depth of shallow roots.

A third point worthy of consideration in this connection, is the fact that the orange grower must fertilize for two distinct purposes, with quite unlike requirements. He must feed both tree and fruit. With bearing trees both these requirements must be supplied at the same time. With trees which should be in fruit, but are for some reason unproductive, intelligent fertilizing is the most efficient corrective. The most important practical deduction is, that

the young grove, before it comes into bearing, needs treatment for trees alone and should be fertilized quite differently from the grove, possibly of the same age, which has not yet reached the fruiting stage.

Forms to apply. With all crops in which the special properties dependent on aroma and flavor control value, the form in which the plant food is supplied, is of very great importance. This is particularly true of the orange, the appearance, quality and flavor of which so largely influence market returns. This importance is greatly increased by the well recognized fact that the health of the tree itself may be so effected by certain common forms of fertilizer.

The source of the phosphoric acid supply, seems to be immaterial so far as results are concerned. Economy of cost of the actual plant food is the controlling factor with this food. The less quickly available forms, bone-meal, soft phosphate and Thomas slag may be used for permanent tree making materials. For regular feeding and quicker results acid phosphate should be the standby

The best form of Potash to supply the orange tree is the Sulphate of Potash or Sulphate of Potash-Magnesia. The former can be used where transportation enters largely into the cost of getting the Potash to the grove and can be used on young trees to good advantage. The latter (commonly known as low grade Sulphate or Double Manure Salt) is considered the best form for fruiting trees on account of the magnesia which it contains, which is not found in the other

forms of Potash Manures. A grove in Florida on which no other form of Potash has been used for a period of twelve years, is noted for producing fruit of the finest flavor, beautiful color and good keeping qualities. Hardwood ashes can also be used to good advantage occasionally, as the alkali in the ashes will neutralize any acid that may have accumulated in the soil, which will better enable the tree to take up the plant food which is placed within its reach.

In selecting the form of nitrogen the greatest precaution is needed. Stable manure should as a rule not be permitted near orange trees. Although even cow and sheep manure has been used in connection with a supplementary application of potash and phosphoric acid, there is danger of a rank growth, thick skinned fruit with excess of rag and inferior flavor, with even splitting and dropping, if stable manure is used alone. Still more to be guarded against is the "die-back" almost sure to follow the continued use of a fertilizer containing too much nitrogen. Other organic forms of nitrogen, such as cotton-seed meal, tankage and blood, possess much the same tendency as manure and should be used with great caution except on the soils noticeably deficient in organic matter, and preferably for tree growth, before the fruit period.

Nitrate of soda is the ideal source of nitrogen. Sulphate of ammonia stands next. Between these two the cost of actual nitrogen at the time of purchase, may safely be the basis of selection. Mineral forms of nitrogen should be used to the rigid exclusion of organic forms, except under the restrictions mentioned.

Secondary effects of fertilizers. Primarily fertilizers are the raw material from which nature is to produce trees and fruit. There are certain well recognized other effects which must not be overlooked, in any full consideration of orange fertilizers.

Certain fertilizing materials, particularly kainit and nitrate of soda, possess well recognized insecticidal properties, probably of some direct value in the orange grove.(*) The most important secondary effect of fertilizers is exerted on the water content of soils. To this the increased drought-resistant powers of soils fertilized with certain mineral salts is due.

Nitrate of soda and kainit both materially increase capillary action in soils. More water moves upward from the lower strata and thus comes within reach of the roots, when the soil has been fertilized with either of these materials, because the moving water has become a dilute solution of these salts. This fact is not only susceptible of scientific demonstration, but accords with practical experience. Growers frequently explain their observation on this point, by the supposition that these materials absorb atmospheric water, and thus increase the available supply. The real explanation lies in the well known power of certain salts of potash and soda, to increase surface tension, and consequently the capillary movement of soil water.

This action is so important that it may well exert a con-

(*) Prof. H. J. Webber in "Citrus Culture in Cala." by State Brd. of Hort. 1900.

trolling influence in determining the selection of the form of fertilizer, when no counteracting objection to the use of the material exists. Kainit is not a desirable plant food for bearing groves; but nitrate of soda is one of the accepted forms of nitrogen. Its influence on the water content of dry sandy soils, particularly in Florida during the often occurring "May drought" is sometimes sufficient to save a crop of fruit which might otherwise be lost.

It is well here to mention the fact that organic manures have the opposite effect, and increase the dryness of soils during scarcity of moisture.

Relations to quality of fruit. The variations in quality of oranges are so great, and their value is so influenced thereby, that the recognized relations between fertilizer used and fruit produced are worthy of careful consideration.

Phosphoric acid possesses slight specific influence, after the demands of normal development have been supplied. Organic forms of nitrogen are detrimental to general quality, result in coarse texture, thick rough skin, excess of rag and lack of good flavor. Nitrate of soda is sometimes claimed to increase the sourness of the fruit, but apparent cases may usually be traced to the comparative lack of potash, resulting in a disproportionate amount of nitrogen.

Of the three essentials, potash exerts by far the greatest influence on character of fruit. Thinner skin, larger proportion of pulp and sweeter juice are the acknowledged effects of potash. So marked is this influence that the experienced grower in Florida where the science and art of

orange fertilizing is developed to the highest degree, will unhestitatingly pick out the fruit resulting from sufficient potash supply, from that produced in the same grove with lack of this essential.

Time and Method of application. The orange blooms in the Spring. The flower is produced on wood matured the previous season. It is thus apparent that the fertilizer or food which supports the bloom and young fruit, must have been consumed by the tree during the previous season.

Fertilizer should be applied at least twice during the year. Bearing trees will do better with three or four applications. February, June, September and November are the proper months and intervals. The first may be called the bloom, the second the fruit and the last two the wood fertilizing. The former two applications should therefore be comparatively strong in nitrogen; the final fertilizing of the season should be particularly a potash application. The phosphoric acid may remain constant. Proportions and quantities will be separately considered. All applications should be apportioned to the individual trees, the party applying same should walk with the right hand to the tree, throwing the fertilizer toward the center in the same manner that seed is sown. This will allow sufficient fertilizer to drop at the edge of the trees for all necessary purposes and put the bulk in the center, where the mass of feeding roots are located. It should be either hoed or cultivated in.

A common tendency to apply very close to the trunk of the tree should be avoided, except during the first two or

three years. The circle of application should be gradually widened till the tree is eventually compelled to seek its food through all the intervening space between the rows. There is no danger of fertilizer needed by the tree, escaping its search. The larger the fertilized circle, the greater the area from which the tree will draw its supply of moisture and natural food.

Quantity and proportions. As has already been shown, he amount, character and proportions of fertilizer which should be given to growing trees and to bearing groves are materially different. Each must, therefore, be considered separately in this connection.

Six years may be accepted as the age at which the average grove may be expected to come into profitable bearing. Sweet seedling trees may require four years longer for reaching this stage. Certain varieties, particularly the Satsuma on trifoliata stock, are very early bearers, even producing fruit in the nursery row. The age limit, therefore, is only comparative and must be accepted with these modifications.

The quantities named are for each tree, since the number of trees per acre is so variable. Two different sets of formulas are suggested, one for sandy and one for heavy or hammock soils.

GROWING TREE FERTILIZERS.

The ability of the tree to use fertilizer during the season of its being transplanted is comparatively slight. After the first year the basis of plant-food supply for the tree should be about the following amounts per year:

(a) Light Soils.	Phosphoric acid	.6	lbs.
	Nitrogen . . .	.4	"
	Potash. . . .	.6	"
(b) Heavy Soils.	Phosphoric acid	0.6	lbs.
	Nitrogen . . .	0.2	"
	Potash. . . .	0 6	"

These proportions of actual plant food must necessarily be supplied to the grove by the application of mixed fertilizers, or of the different fertilizing chemicals required to furnish the quantities of the tree essentials mentioned.

The properly mixed fertilizer containing these quantities of actual plant food would have about the percentage composition of, Phosphoric Acid, 6 per cent; Nitrogen 4 per cent and Potash 6 per cent. One half of the nitrogen is to be omitted from the application to heavy soils.

The following materials may be advantageously applied for supplying the fertilizer requirements of 100 trees. Acid Phosphate, 500 lbs., Nitrate of Soda, 175 lbs., Cotton-seed Meal, 200 lbs., Sulphate of potash, 125 lbs. On heavy soils the cotton-seed meal should be omitted, and the nitrate of soda be depended on as the entire source of nitrogen.

Dissolved bone-black may be substituted for the acid phosphate, sulphate of ammonia for the nitrate of soda, and sulphate of potash-magnesia for the muriate of potash, when convenience or economy make these forms the preferable source of supply. The substitution of either of these materials should be made on the basis of their percentage composition, so that the quantity used shall contain the same quantity of actual plant food as called for in the above formula. As all fertilizer materials are sold on their analytical composition, the substitution is very simple. For instance: Suppose that sulphate of ammonia happens to be more economical or desirable, in some case, than the nitrate of soda mentioned, so that a substitution of the former for the latter is desired.

The quantity of nitrate of soda called for is 175 lbs. This must not be replaced by an equal number of pounds of sulphate of ammonia, which is richer in nitrogen, but by the quantity of the latter necessary to give the same amount of nitrogen contained in the 175 lbs. of nitrate. The latter contains approximately 15 per cent of nitrogen, while the sulphate contains 20 per cent. 130 lbs. of the sulphate of ammonia, therefore, contains as much nitrogen, as 175 lbs. of nitrate of soda, and is the proper quantity to be used in the substitution. With this principle in mind the grower may vary the ingredients of his fertilizer mixture at will, from the desirable materials at his command, and still not alter the supply of actual plant food made accessible to the tree.

The quantities to be applied to the trees must necessarily depend on age, condition and previous treatment of the soil. The first year 2 to 3 lbs. of the mixture recommended will meet the needs of the tree. One half of this quantity should be applied at the time of transplanting by putting it in the hole at lest ten days before the time the tree is put out and thoroughly mixing it into the soil, the more thoroughly it is mixed with the soil, the better it will be for the tree. The other half may be put on either in June or July.

The annual application should be regularly increased as the tree grows. The rate of increase may be approximately one half each year, till the tree is from 4 to 6 years old, when it may be expected to be far enough advanced in crop producing to be placed in the list of bearing trees and be treated with the bearing tree fertilizer.

As a guide to the proper individual application to trees, the following may be accepted as good practice:

1st year, 3 lbs.; 2nd, 4 ½ lbs.; 3rd, 6 lbs.; 4th, 9 lbs.; 5th, 12 lbs.; 6th, 15 lbs. The age at which the change from tree to fruit fertilizer may be made cannot be foretold. It varies greatly, even with the same varieties. The Satsuma is a particularly early bearer, and often makes a crop the third year. Even with such early productivity however, the tree will remain more important than the bearing of fruit, for a year or two longer, since tree-making is indispensable to future fruit making.

BEARING-TREE FERTILIZERS.

With oranges, as with any plant, the composition of the crop produced, must be the basis of rational food supply. This material is actually removed from the soil, therefore the quantity of the crop, or fruit to be provided for, is the starting point for the rational fertilizing of the grove. The average amounts of the three essential plant foods, shown by analysis to be present in the fruit, becomes the practical basis for the economical and satisfactory fertilizing of bearing orange trees.

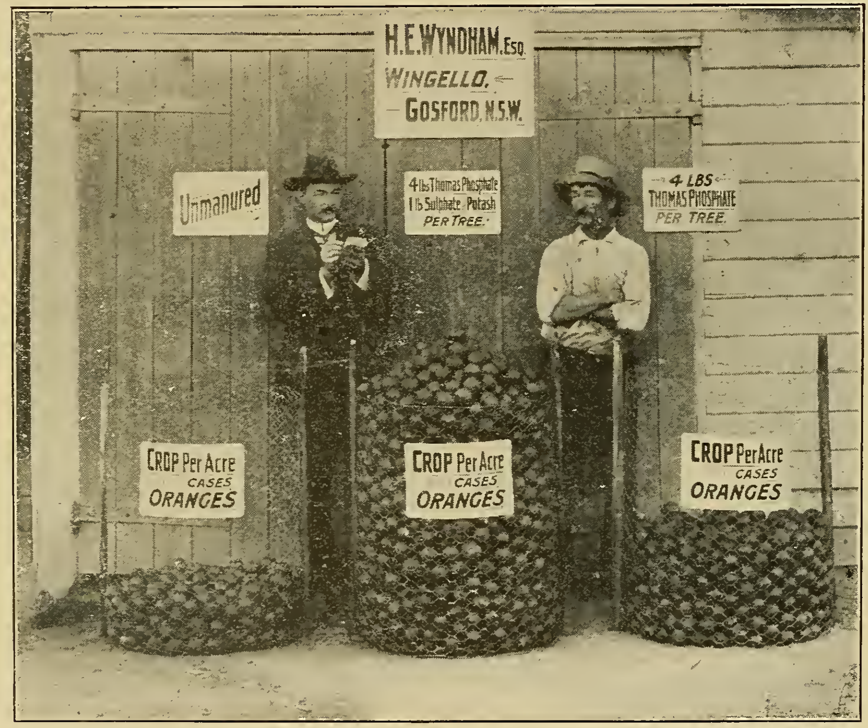
Fertilizing Ingredients in Oranges.

20,000 lbs., 300 boxes.

Phosphoric acid	0.06 per cent	12 lbs.
Nitrogen . . .	0.14 "	28 "
Potash	0 25 "	50 "

Adopting 20,000 lbs. of fruit, equivalent to 300 boxes, as a convenient crop basis, the above amounts of each of the three actual plant food requirements would supply the demands of the crop for material for its growth. It must be remembered, however, that this material only represents the fruit, and provides no supply for the needs of the tree on which the fruit is produced. The actual demands of the grove on which 300 boxes of oranges were to be made, therefore, would be more nearly represented by combining the plant food requirements already specified for the growing tree with the material now shown as necessary for producing the fruit that tree is to bear.

Experience, however, has shown that economical grove fertilizing necessitates certain modifications of this theoretical basis. Less nitrogen and more phosphoric acid than indicated by the mere composition of the tree and its fruit, are found to best meet the continued wellfare of the



RESULTS OF EXPERIMENT, BY H. E. WINDHAM, GOSPORT, N. S. W.

WITHOUT FERTILIZER	COMPLETE FERTILIZER, WITH POTASH	FERTILIZED WITHOUT POTASH
120 CASES PER ACRE	570 CASES PER ACRE	220 CASES PER ACRE

grove. Nitrogen is partly provided through the action of nitrifying bacteria on the nitrogen of the air, particularly when the intervention of a leguminous cover crop is

secured. Phosphoric acid may profitably be used in some excess of the actual demands of the crop, because it is to an extent subject to leeching, and moreover, assists in liberating otherwise unavailable plant food of the soil. The application of potash in close conformity to the demands of the crop, as shown by analysis is found to best meet the requirements of the grove.

A fertilizer which shall supply 100 trees with 72 lbs. of phosphoric acid, 40 lbs. of nitrogen and 122 lbs of actual potash will meet the plant food requirements of the average 300 box grove. This, therefore may advantageously be adopted as the basis, or normal application for the rational fertilizing of the bearing grove. It will be noticed that the relation between these three different plant food constituents in the normal fertilizer is approximately as follows: Nitrogen 1; Phosphoric acid 2 and potash 3. These proportions should be approximately preserved in the composition of fertilizers on this basis. Taking nitrogen, the smallest constituent in quantity required, represented by 1, the application of phosphoric acid should be about 2 times as much and the potash about 3 times as much as the amount of nitrogen applied. The percentage composition of a mixed fertilizer containing these quantities and proportions should be about as follows:

Phosphoric Acid (available)	7	per cent.
Nitrogen	3.5	"
Potash	12	"

A mixture of fertilizing materials to give approximately the above number of pounds of plant food could be made of

255 lbs. Sulphate of Potash, (48% Potash,)		122.40 lbs.
515 lbs. Acid Phosphate, (14% available,)		72.10 lbs.
267 lbs Nitrate of Soda. (15% nitrogen,)		40.05 lbs.
1037 lbs.		

Worked out on the ton basis it would give the following formula:

492 lbs. Sulphate Potash, (48% Potash,)		11.85 lbs.
994 lbs. Acid Phosphate, (14% available,)		6.95 lbs.
514 lbs. Nitrate Soda, (15% nitrogen,)		3.86 lbs.
2000 lbs.		

In calculating the above, the minimum analysis of the material used is taken, to be sure that the analysis does not under-run. Nearly all materials over-run sufficiently, however so that a fertilizer made on above formula would be sure to analyze

12.00% Potash.
7.00% available Phosphoric Acid,
3.90% Nitrogen,

The same plant food essentials may be supplied in different forms, the use of which must depend on convenience, economy and their adaptability to the crop to be grown. The following materials will give a variety from which to select:

Potash, 122 lbs. Actual Potash Require

Sulphate Potash, 48%	255 lbs.
Double Manure Salt, 26% . . .	470 "

Available Phosphoric Acid 72 lbs. require

Acid Phosphate 14%	515 lbs.
Acid Phosphate 16%	450 "
Dissolved Bone Black 18% . . .	400 "
Acid Phosphate 8%	900 "

Nitrogen, 40 lbs. require.

Nitrate of Soda, 15% Nit. . . .	267 lbs.
Sulphate of Ammonia, 20% Nit. .	200 "
Dried Blood, 16% Nit.	250 "

These materials may be applied singly or mixed as complete fertilizers, the different ingredients to be varied according to the conditions of the market and convenience of the grower. Since only mineral materials more or less absorbent of moisture, are included, they should not be mixed except for use in the near future. They will cake and become hard or nubby, if allowed to remain several months before use.

The proportions mentioned are intended to remain fixed. The total quantities to be applied, however, must vary with the age requirements of the trees and condition of the grove as well as general fertility of the soil. These quantities are suggested as a basis, and may be accepted as meeting the average requirements of the 300 box grove.

A grove, producing 300 boxes is, however, only at the beginning of its period of bearing. The quantity of fertilizer to be applied must be increased with the increasing growth and increased demands of the tree. The total application recommended for 100 trees and 300 boxes of fruit, was 1037 lbs. of the above mentioned mixture. This rate of 10.37 lbs. per tree should be increased in proportion to the increased yield of fruit. Trees yielding 10 boxes each should receive this fertilizer at the rate of 35 to 45 lbs. per tree. After the ten box stage is reached, the proportional increase in the fertilizer may be somewhat diminished, because at this stage of production the growth of the tree itself does not increase in proportion to the increase of fruit, and thereafter makes less demand on the fertilizer.

In mixing or using of the different materials recommended, the actual percentage of the different essentials, potash, phosphoric acid and nitrogen in the mixture must necessarily vary, though the actual amount of each of them may remain the same. This matter is often the source of misunderstanding. It therefore deserves special consideration.

The percentage composition of any fertilizer must necessarily vary with the raw materials composing same, since the per cent does not refer to the actual quantity of plant food present, but is simply an expression of the fact that the amount of the specified article of the combination is so many per cents or hundredths of the whole mixture.

By a comparison of the two different fertilizers con-

taining the same quantities of each of the three essentials, but made up of different raw materials, giving different percentages, this fact becomes clear.

The per cent must depend on the total quantity of which it is a part. A half or tenth or hundredth, of per cent, of 1000 lbs. is quite different from the same proportion of 1500 lbs. Ten per cent of a fertilizer mixture consisting of a total of 1000 lbs. must be quite different from ten per cent of a different mixture amounting to 1500 lbs. though each may contain the same total amount of each kind of plant food present.

COMPARISON OF PERCENTAGE AND COMPOSITION

	Pounds of Material	Amount of Plant Food.	Per cent of Plant Food.
Sulphate Potash, 48%	255	122.40	11.85
Acid Phosphate, 14%	515	72.16	6.95
Nitrate Soda, 15%	267	40.05	3.86
Total,	1037.		
Sulphate Ammonia,	200	40.00	2.55
Acid Phosphate, 8%	900	72.00	4.58
Double Manure Salt, 26%	470	122.22	7.77
Total,	1570.		

This comparison makes very evident the mistake of estimating the plant food content of mixed fertilizers by

their percentage composition. Instead of stipulating the per cent of each essential required in a mixture, the actual amount of each of the three plant foods desired should be specified.

Another erroneous supposition of many users of fertilizers should be mentioned in this connection. Many well meaning advisers of growers, ignorant of all details of the actual business of making and selling fertilizers, constantly speak of "make weights" and "fillers" in connection with commercial fertilizers. These allusions have led to the common belief among uninformed persons, that mixed fertilizers often contain materials put in for the sole purpose of bringing the total quantity of material in mixture up to 2000 lbs. as the ton is the unit of commercial transactions, and that in order to buy a small amount of plant food, they are obliged to pay not only for the so called filler, but high freight rates on a material which is useless. As a matter of fact there is little actual filler in fertilizers, (especially those of high grade) as the reputable manufacturer prefers to have an overrun rather than resort to the use of "make weights." However when a specified percentage is insisted on (and at same time, the kind or source of the materials to be used is specified) it would be necessary for the manufacturer to use filler, providing the original material is concentrated and, the consumer insists on buying the goods by the ton.

As a rule however, since the manufacturer decides on the percentage composition of the fertilizer and has at his

disposal for compounding the same, desirable raw material varying greatly in strength or concentration and can combine them to secure the desired percentage of each essential in each ton of mixture, he is able to make most any desired mixture without the use of "filler."

All fertilizers contain **actual** plant food having a definite commercial value, combined chemically with material which has little or no commercial value as plant food. This latter material is in no sense "filler" but is just as necessary as the plant food itself, being in most cases essential in conserving the actual plant food until the plant or fruit can make use of it. Filler or "make weights" contain no plant food.

With these facts before him the orange grower is in possession of the information which should enable him to economically supply his grove with the materials essential to its continued productiveness.

It must not be inferred that these fertilizer suggestions meet every case and condition. They are simply the basis for intelligent action. The formulas given will maintain the productiveness of the average grove under normal conditions. It does not follow, however, that the same end may not occasionally be advantageously attained by other means. When the grower is so skilled as to unerringly diagnose the indications of his grove, and thereby interpret its food requirements, he may vary, or even omit, one of the ingredients mentioned, or obtain the same by other means. Until he is thus skilled, however, he will usually do well to follow the route marked out by successful predecessors.

SINGLE BRANCH OF GRAPE FRUIT.

FROM TREE FERTILIZED WITH COMPLETE FERTILIZER.

IRRIGATION.

The necessity, or desirability, for artificial water supply for the grove, must depend entirely on locality. In California it is absolutely indispensable, wherever orange growing is a commercial industry. In Florida it is frequently provided as protection against damage from drought, which often occurs soon after the young fruit has set, and occasionally results in serious dropping.

Methods in the two states are wholly unlike, as conditions are unlike and direct objects are different. In California ditch irrigation is the sole form practiced. In Florida the general level of the country, and very porous nature of the soil, render ditches useless. Piping the groves and the overhead spraying of the trees, in the guise of artificial rain is, usually resorted to where the natural supply of water is augmented. Artesian and pumped surface water are both utilized. The month of May is about the only time when an artificial water supply is ever found desirable. Only a very small proportion of the groves are provided with facilities for irrigation.

California has generally adopted the furrow system. About four furrows are run between the rows of trees; down these the water is allowed to flow slowly. Care is exercised that the water does not come in direct contact with the trunks of the trees. Scalding and "foot rot" would be apt to follow. Cultivation must be thorough and follow the water as soon as the surface is dry enough to work,

The so-called "irrigation hard-pan" formerly so serious a detriment to California groves, and for which sub-soiling was believed to be the only remedy, is now effectively overcome or prevented. The immediate result of sub-soiling, was serious damage from the destruction of feeder roots. The present practice is to run three furrows a foot deep between the rows. Water is allowed to run slowly through these for several days, till the sub-soil is wet and softened. The surface still remains so dry that it may be worked. The furrows are cultivated full of dry soil. Evaporation is prevented and water conserved. The deep irrigation over-comes the hard-pan, which results from frequent and constant shallow watering and cultivation to a single depth.

WIND PROTECTION.

Orange trees exposed to continuous high winds, especially sea breezes, as is the case in southern California and on the east coast of Florida, are greatly benefited by intervening wind-breaks. These are best provided by plantations of rapid growing heavy foliaged trees. In California the eucalyptus and cypress are most satisfactory. In Florida the camphor and bamboo are successfully used for the same purpose. Since most Florida groves are set out on timbered lands, a belt of natural timber, about fifty feet wide, is the more common wind-break.

FROST PROTECTION.

It must be remembered that the orange is distinctly subtropical in nature. Though it possesses considerable forced hardiness against cold, frost is entirely foreign to its nature and its culture in both California and Florida has become extended far toward the line of serious menace. In both states protection against occasional disastrous cold, has become a regular practice with prudent growers.

Conditions in the two sections do not differ materially in the amount or frequency of the protection needed. Both possess large areas where damaging cold is entirely unknown. Each has many orange groves in sections where preparation for protection is regarded as an advisable form

of grove insurance. In both cases protection of early bloom, against the possibility of damage from late frosts is the most common expedient.

The whole world is aware of the great devastation wrought in Florida by the freeze of February 1895 whereby property of the value of $27,000,000 disappeared in a single night. So many people are ignorant of the real conditions,

VIEWING THE DEVASTATION OF THE FREEZE OF 1895.

and consequently misinterpret results, that a brief presentation of the actual facts is deemed advisable.

The freeze which destroyed so large a part of the groves of Florida was without precedent. It was as much out of the range of human expectation, as was the destruction of Martinique by the eruption of Mt. Pelee. The climate of Florida has not changed. The lowest temperature ever

recorded in the State, was as long ago as 1835. The temperature was within one degree of being as low in 1886 as at the time of the disaster of 1895. Yet the former resulted in little serious damage to groves, while the latter annihilated them. The reason for the difference was the unprecedented conjunction of circumstances acting together.

On December 29th, 1894, the thermometer at Jackson-

AFTER THE FREEZE OF 1895.—TREES TRIMMED BACK TO TRUNKS.

ville, on the very northern edge of the orange section, fell to 14 degrees, the lowest point reached in 60 years. Trees, however, escaped serious harm, but they were naturally entirely defoliated. The severe cold was followed in a few days by three weeks of continued extremely warm weather. The defoliated trees began to grow, nature rushed to repair the damage. By the end of the first week in February they

were covered with tender buds, fresh shoots and half formed leaves. Then on February 8th came another extremely cold snap; the thermometer again dropped to 14 degrees, and the trees, full of sap, were killed to the ground.

It is easily seen that it was not unusual cold, but phenominal conjunction of circumstances, which brought disaster to Florida.

Protection against cold, naturally assumes two distinct phases. Namely influencing the resistance of the tree itself and actual protection against external conditions.

Dormancy. All horticulturists recognize the importance of this condition of the tree, as bearing on its susceptibility to cold. On this point Dr. H. E. Stockbridge, in perhaps the most complete presentation of the subject published, says: (*) "The tree must be kept as nearly dormant as possible, from the first of December till the first of March. All means conducive toward this end are positively our best and most effective protection against the possibilities of damage from frost." He recommends the following means toward this end:

1. Omit the working of all groves from September till February.

2. Exclude all nitrogenous or ammoniated fertilizers during this period.

3. Root-pruning, carefully practiced around one-quarter of the tree is conducive to dormancy.

(*) Report Florida State Horticultural Society 1899.

4. Varieties, particularly of stocks, should be selected with special reference to dormancy, or late spring starting, in which particular they vary greatly. The hardiness of varieties is chiefly a question of dormancy.

Water and forest protection. Living trees and large bodies of water are invariably several degrees warmer than the surrounding air. They must therefore exert some warming influence on the atmosphere. If the prevailing wind is from the forest or water, toward the grove this effect may be sufficient to prevent frost, or to mitigate damage. Growing vegetation, hedges and fences, intervening between the water or forest and the grove, interfere with the free movement of the air, and are consequently harmful. This is particularly true of the growth often left bordering bodies of water, which prevents the warm air moving over them.

Artificial Shelter. Very many forms have been extensively tried in both California and Florida. Tents of various designs, with and without heat, are now practically discarded. In California artificial heat is now depended upon and in Florida only one general form of shelter remains in real use. This is the slatted shed, built permanently over the grove. It gives about three quarters closed and one quarter open space. Woven lath and wire fencing material is the form of construction used. Wooden posts and frames, are strung with galvanized iron wire for sustaining the cover. The posts are usually left 12 to 16 feet out of the ground. The cost of such sheds is about $400.00 to $500.00 per acre. They are of course adapted

only to medium sized trees. They furnish protection to the extent of from 4 to 6 degrees, when closed on the windward side. They have some value in shading the grove during the summer, and thus preventing loss of nitrogen and moisture from the soil. On the other hand, they harbor insects and other tree pests. Their general use is not probable.

The Use of Heat. Dry heat and moist heat are both extensively used both in California and in Florida. Each has a different direct object. The former is resorted to for materially raising the temperature of the atmosphere in the grove. The latter is simply a means for preventing the loss of the natural heat of the tree and soil, by evaporation. Its effect is necessarily comparatively slight, a change of from 2 to 4 degrees, and consequent prevention of frost formation only is expected, and is readily attained.

Slow fires or smudges, in California of wet straw, and in Florida of Spanish moss, are the practical methods employed. The smoke produced, settles over the grove, prevents the heat from radiating, and also after the sun rises protects the trees from its heat. This is a most important fact, since it is really the thawing, rather than the freezing which is the immediate cause of the damage.

Dry heat, or actual fires in groves, are common in both California and Florida. Both use the coal basket of woven wire. Twenty or fifty baskets per acre afford the protection sought. A rise of three to five degrees with the smaller number of baskets, when outside tempera-

ture fell to 24 degrees is entirely feasible. (*) These baskets cost only about 25 cents each, and only one quarter to one half ton of soft coal per acre per night is required for their use. Considering the value of the property protected, this is as low a premium for insurance against damage from cold, as is usually paid for protection against fire. Two or three nights during a season will usually cover the period of danger.

In Florida, where groves are often situated in the immediate vicinity of abundant supplies of seasoned pine wood, open fires of this fuel are resorted to instead of the coal basket. The heat produced is greater, and the actual protection is proportionately increased.

(*) Report Riverside Hort. Club, Citrus in Cala. 1900 p. 155.

EFFECTS OF IMPROPER FERTILIZATION RESULTING IN "DIE BACK."

DISEASES AND PESTS.

Though the orange is subject to a few serious pests, the number is not greater than with other standard fruits. These troubles are mostly well understood, and form the subject of separate specific works, particularly the Bulletins of the California and Florida Experiment Stations, to which the grower is referred for full discussion. Only a brief summary of the most important pests can be presented here.

Die-Back. This is the dying back of apparently healthy twigs and branches, usually preceded by a rusty deposit on the bark, from which the name "red rust" is often given to the trouble. This is recognized as a condition of the tree, and not as a distinct disease. **Cause.** Error in nutrition, hard-pan, lack of proper drainage, and excessive feeding with manure and other organic fertilizers. **Treatment.** Remove the cause. Spraying with Bordeaux mixture results in a tonic action on the leaves, greatly improving the condition.

Foot-rot, Gum disease. This is believed to be due to a vegetable parasite. Its presence is recognized by an exudation of gum from the bark, usually near the ground. **Cause.** It is believed to be conveyed by spores or germs in the air. Cow-penning, lack of drainage, excessive use of organic manures, and accidental injury to the bark are believed to be the pre-disposing conditions. **Treatment.** Cut away all diseased parts down to healthy

wood. Paint the exposed tissue with crude carbolic acid. Burn all removed material. All tools used should be disinfected with the carbolic acid wash before being used on healthy trees. The sour stock is less subject to attack than is other citrus wood.

Scab. This consists of warty cork-like elevations on twigs, leaves or fruit. **Cause.** It is thought to be the result of the action of a specific fungus. **Treatment.** Spray with Bordeaux mixture, or with ammoniacal copper carbonate solution.

Sooty Mold. This is a sooty black accumulation on leaf and fruit. **Cause.** It is due to the action of various insects which exude "honey dew." The white fly is the most serious of these pests. **Treatment.** Destroy the white fly by fumigating with hydro-cyanic acid gas. Spray with resin wash or kerosene emulsion.

Orange Scale. This is the scale insect most common to citrus trees. It may accumulate to such an extent as to cause the death of branches, or even trees, through the loss of sap sucked out by the insects. **Treatment.** Spray with solution of whale-oil soap.

PRUNING.

Within a few years a radical change in the general practice of pruning has taken place. Formerly trees were made to branch high, with clean tall trunks. The heads were thinned out to admit access of sunlight. Now low dense heads are the decided preference.

Advantage of Low Heads. The shading of the ground around the tree, thus preventing the soil moisture from evaporating; prevention of sun baking of the soil; ability to support heavier crops without propping; and greater accessibility of fruit, resulting in easier picking, are the chief gains from low-headed trees. Protection of the trunk from damage from sun-scald, is also secured. Thinning out of what was formerly considered as superfluous growth is now practically abandoned for the same reason. Protection of young fruit from hot winds is a further gain.

Branches and sprouts which seriously mar the symmetry of the tree, may be removed, but the pruning knife is becoming less and less in evidence in the best managed groves. All necessary pruning should of course be done while the trees are dormant. Wounds should be painted or otherwise protected from the air.

HARVESTING AND PACKING.

However successful the grower may be in producing fruit, the real success of his business will finally depend on the skill used in harvesting and marketing his crop. A few of the salient points influencing results will be presented.

Picking. Clip, never pull the fruit. The stem should be cut close up to the orange that danger of puncturing neighboring oranges may be avoided. Pick into hand or shoulder baskets and at every stage handle each orange with care. Only fully ripe fruit should be picked. Unlike many other fruits the ripening of oranges never continues after they are removed from the tree.

Grading. Two distinct classes are recognized, and should be strictly adhered to, namely, "Brights" and "Russets." The latter is a distinctly Florida product. At least two grades of each class should be made. The standard grades of California are: Fancy, Choice and Standard. Oranges should cure in the packing house from two to seven days before being packed, to allow toughening of the skin. Wrap in a good quality of tissue paper, preferably with design or trade-mark stamped thereon.

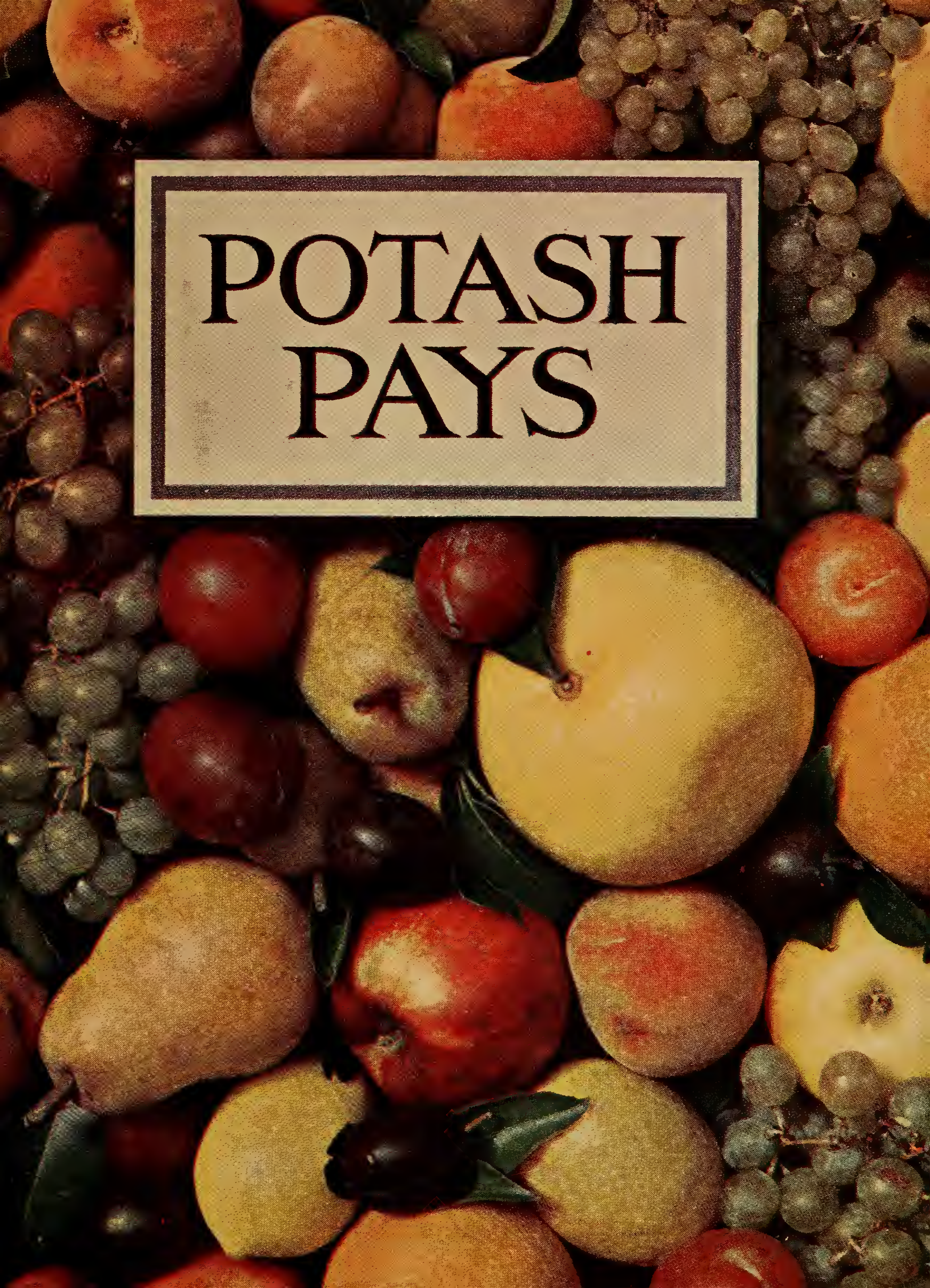
Only oranges of a single size may be packed in a box together. They should be accurately sized by machine. The standard sizes, which refer to the number which a box will contain, are as follows: 96 - 112 - 126 - 150 - 176 - 200 - 216 - 250 - 300. The standard box only should be used

Its dimensions are: 11½ x 11½ x 26 inches, inside measure. Boxes should be filled solid with fruit in rows with broken spaces, and project from ½ to ¾ of an inch above the edges, so that the top may exert pressure and keep the fruit in place.

The outside of the box should always be correctly stencilled with grade, size, variety and address of grower. In this way it is possible to establish a reputation and demand which will have a distinct money value to the producer of good fruit.

TABLE OF CONTENTS.

POTASH PAYS



POTASH PAYS

Practical suggestions to farmers showing how to use fertilizers with profit

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POTASH PAYS

AMERICAN farmers and fruit growers are rightly regarded as the most intelligent, enterprising, and prosperous of their class. Our farmers make a success of their business, because they are up-to-date and ever ready and quick to adopt the latest improvements and the newest methods. They take advantage of the teachings of science, and make practical use of recent discoveries, whereby they increase the fertility of their lands and gather large and profitable crops.

It is no wonder, then, that our farmers in California and other States now pay so much attention to the important subject of supplying plant food to their different lands. They not only *know*, but they have found out that it is necessary to put back into the soil those substances which have been taken out year after year by their crops. Science has shown that potash, phosphoric acid and nitrogen are continually used up from the soil by growing crops. Unless these substances are returned in the form of fertilizers, the farmer's lands will surely and steadily lose their productiveness, and sooner or later his yields of grains, or fruits, or vegetables, as the case may be, will become less and less.

No matter how rich the soil may be, the result is the same, when crop after crop is gathered from the same land. And so when a farmer is asked: "Why do you fertilize your land?" He at once replies "To feed my crops." Fertilizers

are crop foods. It is simply a question of feeding the crops, as it is in feeding live stock on the farm. Just as different animals require different kinds and amounts of food, so the different soils and crops need certain substances, which are contained in a proper fertilizer, for their best development or condition.

Some farmers and fruit growers in California and other States may cling to the old notion that, as the soil is still new, it does not need potash and the other elements which have been removed by the successive crops. But this is a mistake. If they did not need potash, California farmers would not buy the large quantities which they do at the present time. Those who are using potash on their farms and orchards in California are getting a good profit on their investment. Their opinion that "potash pays" is the best testimony to its value. Such an opinion is based upon practical experience and upon the actual results from the increased crops which they obtain from the proper use of potash with the other necessary ingredients.

While certain tests with certain soils in California have shown that they contained considerable potash, yet the important question is: "How much of this potash is available as plant food?" Or, the question may be asked: "Is this potash naturally in the soil in a soluble condition?" If the potash is in an *insoluble* condition it is useless to plant growth, and potash fertilizers must be used in order to obtain proper yields. The mere statement that a chemical analysis shows considerable potash in a soil is not sufficient, for by present chemical methods it is impossible to determine the quantity of plant food which is available to the different plants growing on the soil.

How many of our readers ever carefully considered the large quantities of potash, phosphoric acid, and nitrogen

which are lost, so to speak, each year? Do *you* know the number of pounds of valuable potash taken per acre by any of the leading crops? If not, you should read and study this list:

Table Showing the Amount of Potash Removed by Crops and Quantity of Potash Salts Needed to Return Fertility to the Soil

Crop	Yield	Actual Potash Removed	Muriate or Sulfate of Potash Needed to Return Fertility
Apples	15 tons	60 lbs.	120 lbs.
Barley	*30 bu.	51 lbs.	102 lbs.
Beans	*30 bu.	53 lbs.	106 lbs.
Buckwheat	*34 bu.	40 lbs.	80 lbs.
Cabbage	30 tons	270 lbs.	540 lbs.
Clover (dry)	2 tons	88 lbs.	176 lbs.
Corn	*70 bu.	55 lbs.	110 lbs.
Grapes	*2 tons	39 lbs.	78 lbs.
Hops	*600 lbs.	53 lbs.	106 lbs.
Mixed Hay	2½ tons	77 lbs.	154 lbs.
Oats	*60 bu.	62 lbs.	124 lbs.
Onions	22½ tons	72 lbs.	144 lbs.
Pears	16 tons	26 lbs.	52 lbs.
Peas	*30 bu.	52 lbs.	104 lbs.
Plums	8 tons	40 lbs.	80 lbs.
Potatoes	*200 bu.	74 lbs.	148 lbs.
Rye	*30 bu.	45 lbs.	90 lbs.
Sugar Beets	*15 tons	143 lbs.	286 lbs.
Timothy Hay	2 tons	94 lbs.	188 lbs.
Tomatoes	10 tons	54 lbs.	108 lbs.
Wheat	*35 tons	31 lbs.	62 lbs.

* NOTE: Includes straw, stover, vines, pods, etc. in addition.

All of the foregoing crops also remove from the soil the other two essential elements of plant food, which are phosphoric acid and nitrogen. Of course it is quite necessary that all three of these plant foods be present in the soil in order that the growing crops get suitable food or nourishment. Potash, phosphoric acid, and nitrogen each have their own value and do their separate work; so that one can not take the place of the other. A proper mixture of these three ingredients makes what is known as a "complete fertilizer." The average farmer can usually make his own mixtures. In fact, many farmers prefer to buy their potash and other plant foods and mix them to suit their soil and their different crops. The amounts of potash, phosphoric acid, and nitrogen depend on the nature and condition of the soil, as well as on the kind of crop to be grown.

Another important point to remember is, that the quantities of plant food which each crop actually requires can not be measured by the exact number of pounds of potash and the other plants foods removed by that crop from the soil. The reason is that plant roots can only reach a certain amount of plant food in the soil, while the rest is not taken up. Therefore, practical tests and experience have shown that larger quantities of potash, phosphoric acid, and nitrogen must be supplied than the actual number of pounds per acre removed by the yield.

The practical farmer and fruit grower will ask: "How can I find out just what kind and how much fertilizing material I should use for such—and—such a crop?"

In reply, we would suggest that the farmer or fruit grower make a few simple tests of fertilizers for himself, and this each one can do at a very small amount of trouble and expense.

The best way is to lay out "experimental plots." You

should take small plots of ground of the same size and give each one the same kind of treatment, except as to its fertilization. Three such plots may be laid out as follows:

Plot No. 1

Check Plot —— No Fertilizer Applied

Plot No. 2

Use a complete Fertilizer, containing Potash, Phosphoric Acid and Nitrogen

Plot No. 3

Apply an "Incomplete Fertilizer," containing only Phosphoric Acid and Nitrogen

Now compare the results. The difference in yields on Plots Nos. 1 and 2 will show the *gain* from using a complete fertilizer on the land.

The difference in the yields on Plots 2 and 3 will show the *loss* from not having Potash in the fertilizer.

Just such experiments have been made by a number of practical farmers in California. They cover a wide range of soils in that State and many different crops. The interesting results thus obtained are set forth in the following pages.

EXPERIMENT ON PEACHES

This experiment, made by Mr. H. E. Butler, for the Penryn Fruit Company, clearly demonstrates the value of fertilizers for the orchard. Moreover, it clearly shows the value of Potash in producing large yields of superior fruit.

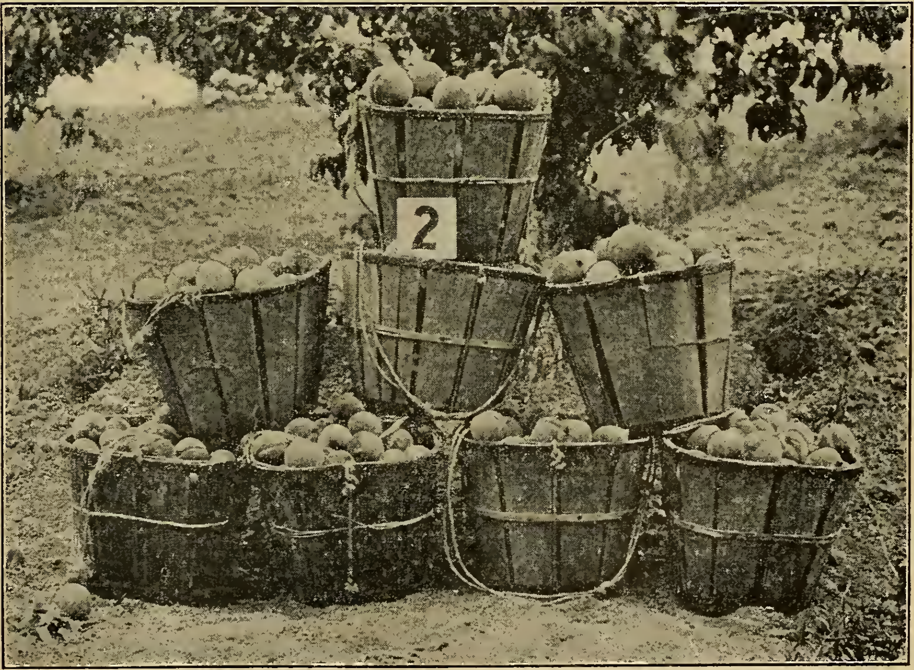
The Lovell peach was the subject of the test and the soil over the acre used for the experiment was a clay loam with a decomposed granite subsoil. The trees were six years old at the time the experiment was started in 1906. There was a crop failure during that year but quite satisfactory crops were harvested in 1907 and 1908, as shown in the following table:

Plot	Fertilizer applied per acre in pounds	Yields per acre in pounds		Increase over unfertilized plot	
		1907	1908	1907	1908
1	No fertilizer	6150	7500	——	——
2	120 Muriate Potash 600 Superphosphate 180 Nitrate Soda	12300	20000	6150	12500
3	600 Superphosphate 180 Nitrate Soda	8610	12500	2460	5000

In 1907 increase from 120 pounds of Muriate of Potash per acre, was 3690 pounds Peaches. In 1908 increase from 120 pounds of Muriate of Potash per acre, was 7500 pounds Peaches. Average increase from 120 pounds of Muriate of Potash per acre, was 5595 pounds Peaches.

Comparative Yields, 1908.   Experiment by H. E. Butler, Penryn, Cal.

Incomplete Fertilizer (NO POTASH) Yield, 6¼ tons per acre



Complete Fertilizer (WITH POTASH) Yield, 10 tons per acre

No Fertilizer	POTASH, Phosphoric Acid, Nitrogen	Phosphoric Acid, Nitrogen
Yield, 56,160 lbs. per acre	Yield, 70,720 lbs. per acre	Yield, 62,400 lbs. per acre

Increase due to Potash, 8,320 lbs. Pears (160 Boxes)

EXPERIMENT ON BARTLETT PEARS

This experiment, by Mr. C. E. Hustler, Cortland, Cal., was conducted on sandy loam, soil in an orchard 25 years old and on trees in good bearing condition. Although there was trouble from blight in some parts of the orchard, this did not affect the results of the experiment.

The following is an account of the amount of fertilizer applied, the yields, and the increase due to the use of fertilizers:

Plot	Fertilizer per acre in pounds	Yield per acre in pounds	Increase per acre over unfertilized in pounds
1	No fertilizer	56160	——
2	180 Sulfate of Potash 600 Acid Phosphate 180 Dried Blood	70720	14560
3	600 Acid Phosphate 180 Dried Blood	62400	6240

Increase from the use of the complete fertilizer was 280 "picking" boxes averaging 52 pounds each. The increase from the use of 180 pounds of Sulfate of Potash was 160 "picking" boxes.

Experiment on Raisins by A. J. Bump, Orosi, Cal.

Increase from 120 lbs. Sulfate of Potash,—536 lbs. Raisins per acre

(See details on next page.)

EXPERIMENTS ON RAISIN GRAPES

The experiment illustrated on the preceding page, conducted by Mr. A. J. Bump, Orosi, Cal., was made in a ten year old vineyard of Muscat Grapes.

Owing to depletion of soil fertility the yields were not very satisfactory, but through the use of fertilizers containing potash a marked increase has been obtained as shown by the following results below:

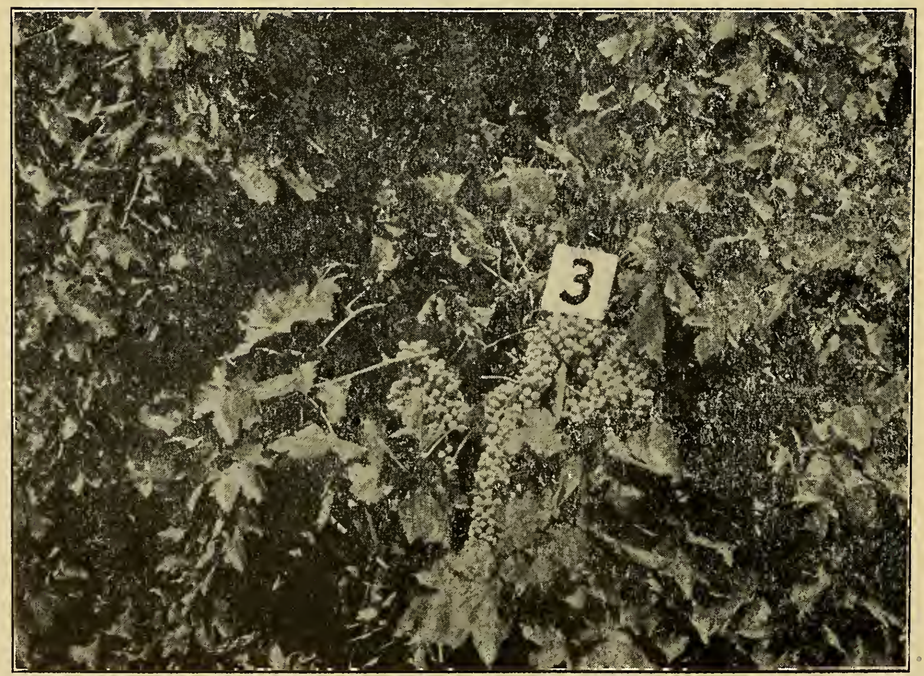
Plot	Amount of fertilizer material applied per acre in pounds	Yield per acre in pounds		Increase over unfertilized plot in pounds	
		1908	1909	1908	1909
1	No fertilizer	1854	2028	——	——
2	120 Muriate Potash 600 Superphosphate 180 Nitrate Soda	2624	2522	770	494
3	600 Superphosphate 180 Nitrate Soda	2088	2132	234	104

The test on grapes described on the following page was made in the vineyard of F. C. Lewis, Fowler, Cal. "Thompson's Seedless" was selected for this experiment, and the results, reported for two years show that potash was essential to the largest yields, a good profit being obtained from its use.

Plot	Amount of fertilizer material applied per acre in pounds	Yield per acre in pounds		Increase over unfertilized plot in pounds	
		1908	1909	1908	1909
1	No fertilizer	2391	3746	——	——
2	120 Muriate Potash 600 Superphosphate 180 Nitrate Soda	5211	4950	2820	1204
3	600 Superphosphate 180 Nitrate Soda	4640	4550	2249	804

Experiment on Seedless Raisin Grapes, by F. C. Lewis, Fowler, Cal.

Plot No. 2 Fertilized with High Grade POTASH Fertilizer



Plot No. 3 Grapes Fertilized without POTASH

EXPERIMENT ON ORANGES

The results of the following experiments made at four different farms, near Porterville and Riverside, should be carefully studied by the practical grower. These trials show large increases produced by using potash fertilizers in conjunction with nitrogen and phosphoric acid.

Experiment by W. H. Grant, Porterville, Cal., Oranges on black adobe over clay subsoil.

Plot	Fertilizer applied per acre in pounds	Yield per acre in pounds		Increase over unfertilized plot in pounds	
		1908	1909	1908	1909
1	No fertilizer	12285	11660	——	——
2	120 Sulfate Potash 600 Superphosphate 180 Nitrate Soda	17940	23328	5655	11668
3	600 Superphosphate 100 Nitrate Soda	15765	17280	3480	5620

Average increase from about $3.50 spent for Potash 4,112 pounds Oranges. See photo page 17.

Experiment by H. C. Carr, Porterville, Cal., Navel Oranges, on deep loam soil (clay subsoil).

Plot	Fertilizer applied per acre in pounds	Yield per acre Picking boxes	Increase per acre over unfertilized plot
1	No fertilizer	648	——
2	600 Superphosphate 180 Sulfate Potash 150 Dried Blood	864	216
3	600 Superphosphate 150 Dried Blood	756	108

The increase from about $5.00 worth of Potash, was 108 boxes. See photo page 18.

Experiment by O. K. Kelsey, Riverside, Cal., on sandy loam soil.

Plot	Fertilizer applied per acre in pounds	Yield per acre in packed boxes	increase per acre due to potash
2	320 Sulfate Potash 1440 Superphosphate 640 Nitrate Soda	391	61
3	1440 Superphosphate 640 Nitrate Soda	330	

Notwithstanding the heavy application, Potash gave a good profit, 61 boxes of Oranges from about $9.00 worth of Potash. See photo page 19.

Experiment by W. E. Sprott, Porterville, Cal., Navel Oranges, sandy loam soil.

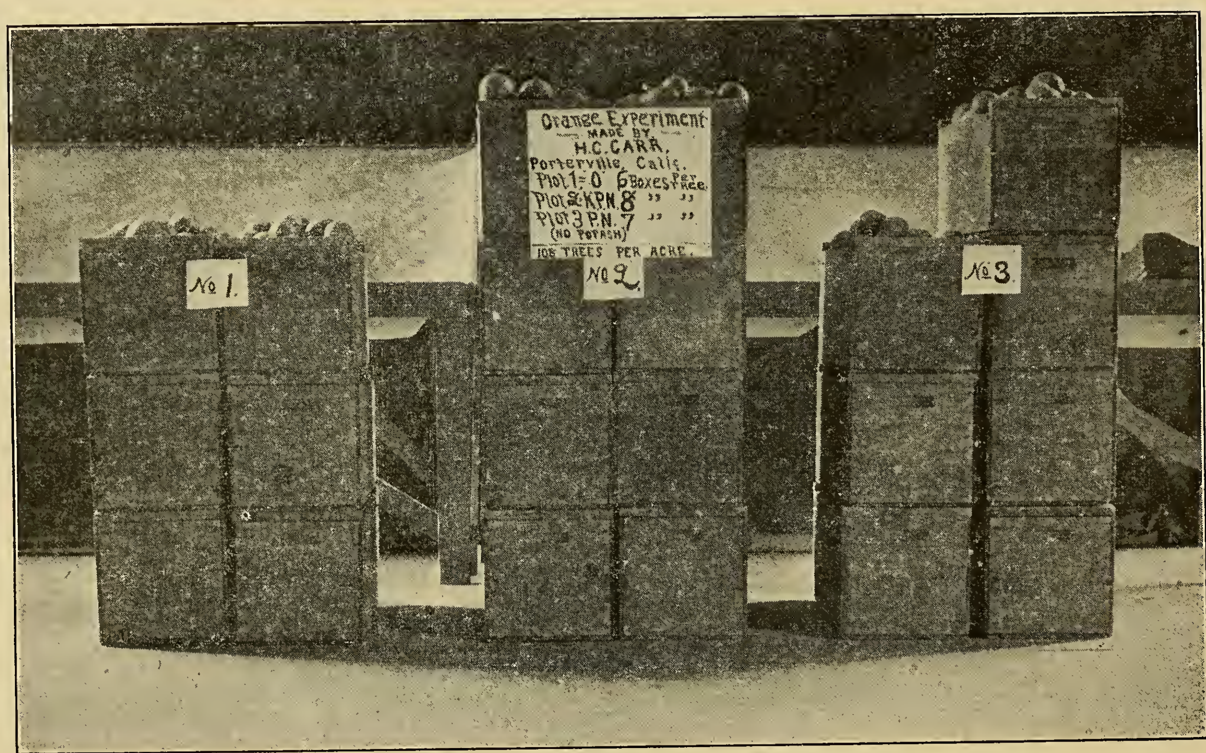
Plot	Fertilizer applied per acre in pounds	Yield per acre picking boxes	Increase per acre over unfertilized plot (picking boxes)
1	No Fertilizer	335	——
2	180 Sulfate of Potash 180 Dried Blood 600 Superphosphate	507	172
3	180 Dried Blood 600 Superphosphate	381	46

Increase from about $5.00 worth of Potash, 126 boxes. See photo page 20.

Experiment on Oranges by W. H. Grant, Porterville, Cal.

Increase (1909) from 120 lbs. Sulfate of Potash,—6048 lbs. Oranges

Experiment on Navel Oranges by H. C. Carr, Porterville, Cal.



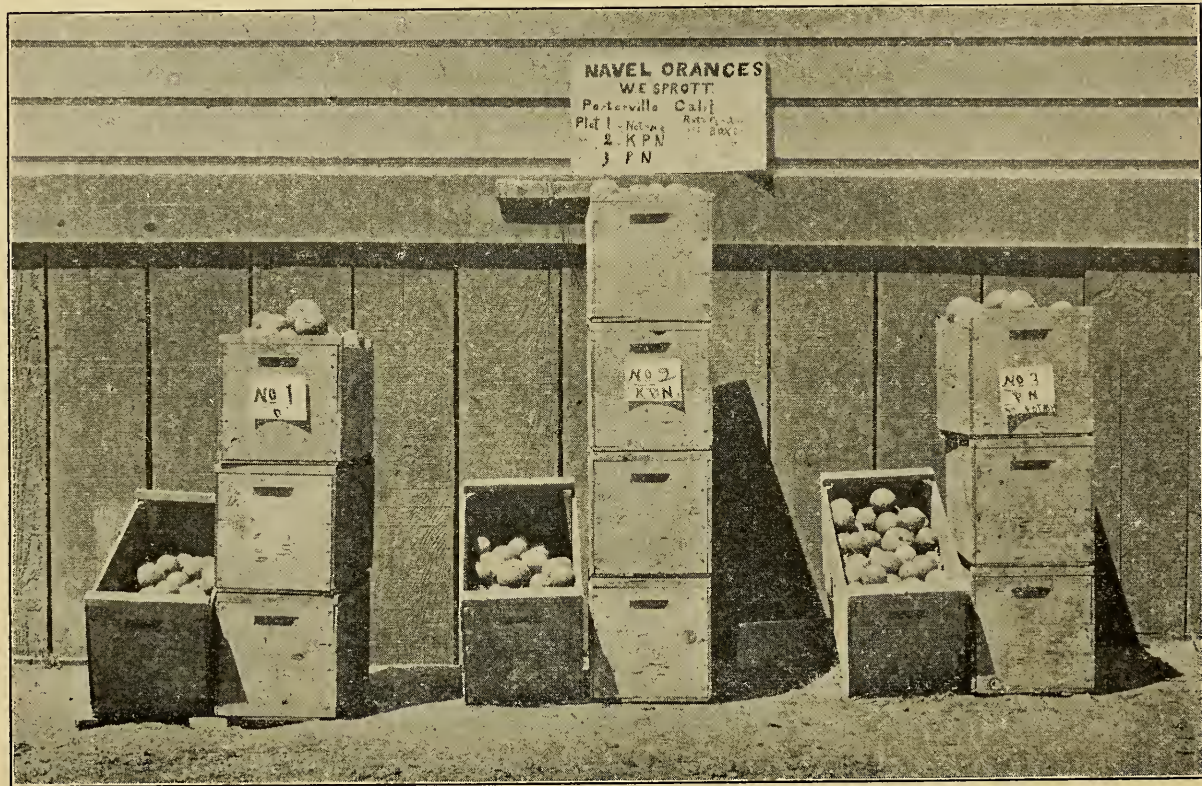
No Fertilizer	With Potash	Without Potash
648 boxes per acre	864 boxes per acre	756 boxes per acre

Increase from 180 lbs. Sulfate of Potash,—108 boxes per acre.

Experiment by Mr. O. K. Kelsey, Riverside, Cal.

Increase from 320 lbs. Sulfate of Potash,—61 boxes.

Experiment by W. E. Sprott, Porterville, Cal.



No Fertilizer
Yield, 335 boxes per acre

POTASH, Phosphoric Acid
and Nitrogen
Yield, 507 boxes per acre

NO POTASH
Phosphoric Acid and Nitrogen
Yield, 381 boxes per acre

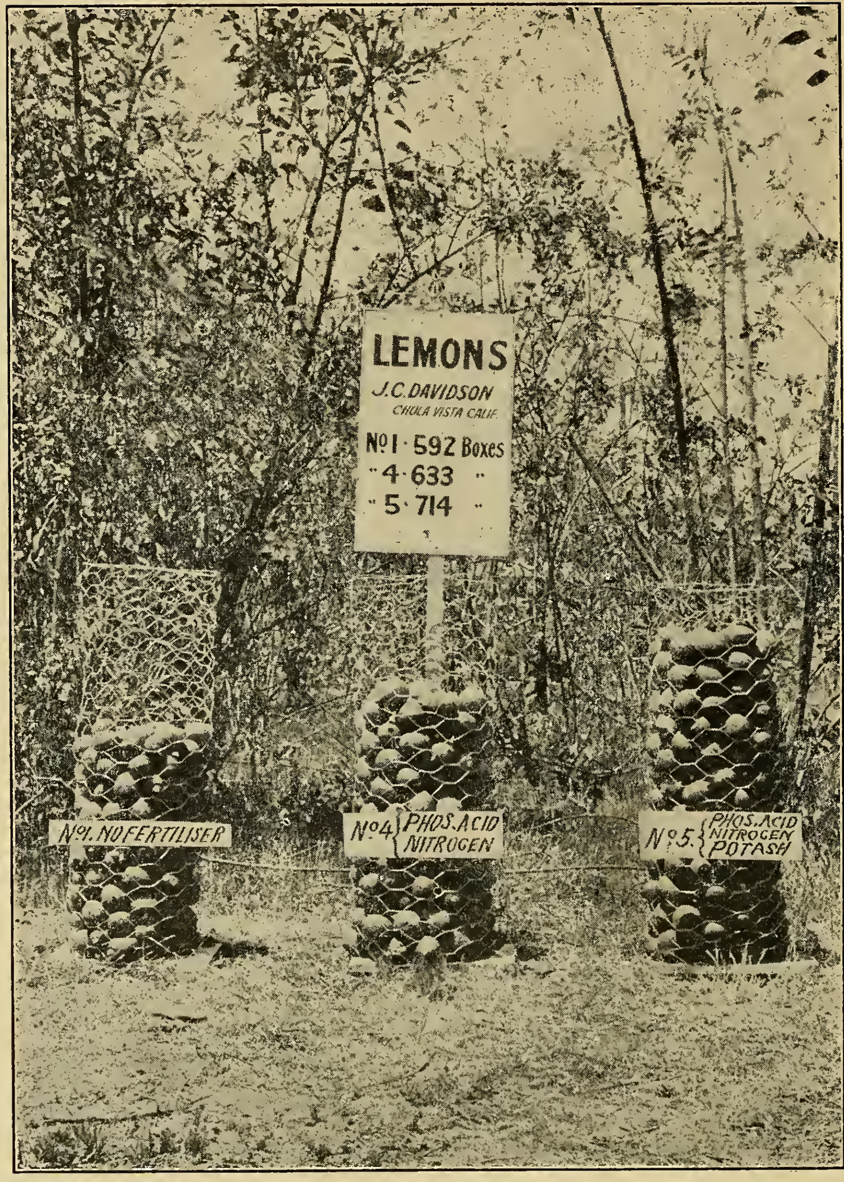
EXPERIMENTS ON LEMONS ON SANDY LOAM SOILS

Here is a record of two experiments on a more elaborate plan made by Mr. J. C. Davidson, of Chula Vista, Cal., and J. R. Caldwell, of El Cajon, Cal. These tests, like those on oranges, show that citrus fruits in California respond readily to the use of fertilizers and particularly to potash.

Plot	Fertilizer applied per acre in pounds	Yield per acre, boxes		Increase over unfertilized plots per acre	
		J. C. Davidson 9 pickings	J. R. Caldwell 4 pickings	Davidson	Caldwell
1	No fertilizer	592	50	——	
2	240 Sulfate Potash 540 Acid Phosphate	708	112	116	62
3	240 Sulfate Potash 180 Nitrate Soda	675	93	83	43
4	180 Nitrate Soda 540 Acid Phosphate	633	104	41	54
5	240 Sulfate Potash 540 Acid Phosphate 180 Nitrate Soda	714	133	122	83
6	360 Sulfate Potash 270 Nitrate Soda 810 Acid Phosphate	724	93	132	43

The increase from the use of 240 pounds Sulfate of Potash per acre, was 81 boxes in the case of Mr. Davidson's test, and 29 boxes in the test made by Mr. Caldwell. It is well to note that Mr. Caldwell's orchard was only six years old and that only four pickings are reported.

Experiment by J. C. Davidson, Chula Vista, Cal.



Increase from 240 lbs. per acre, Sulfate of Potash,—81 boxes.

Experiment on Lemons by J. R. Caldwell, El Cajon, Cal.

No. 1. No Fertilizer **50 boxes per acre**	**Completely Fertilized** **POTASH, Phosphoric Acid and Nitrogen** **133 boxes per acre**	**Incompletely Fertilized** **NO POTASH** **104 boxes per acre**

EXPERIMENT ON CELERY

This experiment was made by W. E. Gerhard, Santa Ana, Cal. It was conducted on loose reclaimed swamp land which had produced a number of crops and was evidently worn out so far as an "*available*" supply of plant food was concerned. This is shown from the fact that the yield was more than doubled by the fertilizer applications. One third of the 90 crates increase produced from the 1300 pounds of the fertilizer used was due to Potash.

The amount of fertilizer applied to each plot, the yield and the amount of increase are shown in the following table:

Plot	Application per acre in pounds	Yield per acre in crates	Increase over unfertilized plot (in crates)
1	No fertilizer	70	—
2	750 Acid Phosphate 300 Sulfate Potash 250 Nitrate Soda	160	90
3	750 Acid Phosphate 250 Nitrate Soda	130	60

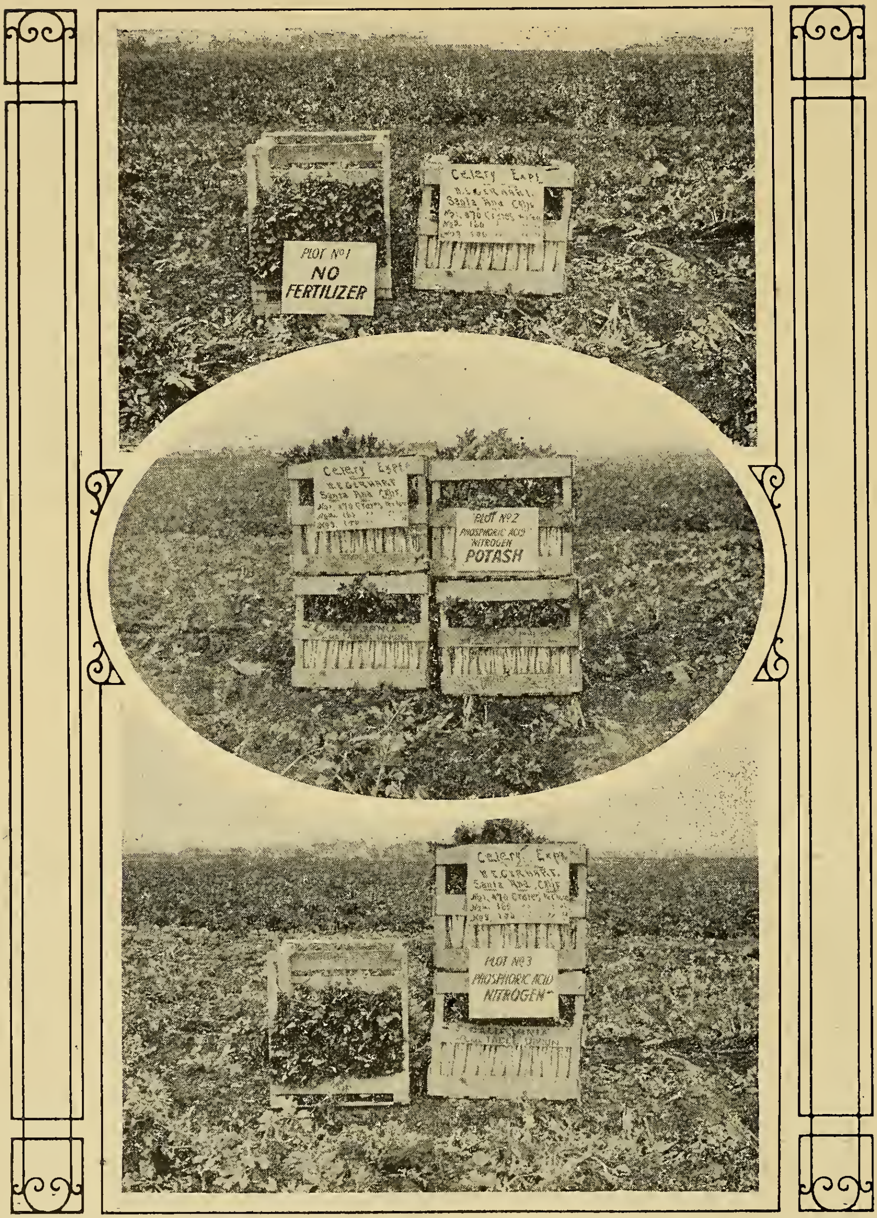
Experiment by W. E. Gerhard, Santa Ana, Cal.
No Fertilizer Yield, 70 Crates per acre

Experiment on Celery by W. E. Gerhard, Santa Ana, Cal.

Complete Fertilizer POTASH, Phosphoric Acid and Nitrogen
Yield, 160 Crates per acre

Incomplete Fertilizer NO POTASH (Phosphoric Acid and Nitrogen only)
Yield, 130 Crates per acre

Experiment on Celery by W. E. Gerhard, Santa Ana, Cal.



Relative Yields
- Plot No. 1 No Fertilizer (70 crates)
- Plot No. 2 WITH POTASH (160 crates)
- Plot No. 3 NO POTASH (130 crates)

SOME SUGGESTIONS ABOUT USING FERTILIZERS

In the Introduction to this booklet we mentioned the fact that many farmers and fruit growers often preferred to buy the ingredients, or "simples" as they are called in California, and then make their own mixtures. This is a good way, when the farmer knows how much potash, phosphoric acid, and nitrogen are needed for the soil and the crop to be grown thereon.

Of course, the most expensive of the three essential elements of plant food is the nitrogen, but fortunately Science has come to the aid of the farmer and has shown him how he can obtain a supply of nitrogen at a very moderate cost. In a few words it may be stated that this supply of nitrogen comes from the air, which is used by the bacteria in the soil and by all leguminous crops, of which clover and cowpeas are the most common. Thus, the farmer who wants to get cheap nitrogen, raises a leguminous crop and fertilizes his soil by turning it under. With proper care and study only comparatively small amounts of nitrogen, which is expensive whether in the form of manure or in a commercial fertilizer, need to be bought, and sometimes it may be omitted entirely, especially when leguminous crops are grown in rotation.

It is different with the mineral fertilizers, that is with potash and phosphoric acid. They must be supplied in certain amounts according to the natural fertility of the soil, the requirements of the crop grown, and the system of cropping.

The following suggestions as to the composition of a good average fertilizer should prove useful to farmers and fruit growers who wish to make their own mixtures. The

quantity to be used will run from 250 pounds up to 1,000 and even 2,000 pounds per acre. The largest yields and profits have been obtained by intensive cultivation with corresponding intensive use of fertilizers.

Citrus Fruits *For Growing Trees*

Nitrogen	**4 per cent.**
Phosphoric Acid	**8 per cent.**
Potash	**7 per cent.**

Sulfate of Potash	300 lbs.
Nitrate of Soda	500 lbs.
Acid Phosphate (16%)	800 lbs.
†Bone Meal	400 lbs.
	2000 lbs.

From three lbs. per tree for the first year, to 15 lbs. per tree for the sixth year is usually considered a fair application.

For Bearing Trees

Nitrogen	**3½ per cent.**
Phosphoric Acid	**8 per cent.**
Potash	**12½ per cent.**

Sulfate of Potash	525 lbs.
Acid Phosphate (16%)	1000 lbs.
Nitrate of Soda	475 lbs.
	2000 lbs.

From ten to twenty-five pounds per tree is the usual application.

Deciduous Fruits *For Growing Trees*

Nitrogen	**3 per cent.**
Phosphoric Acid	**9½ per cent.**
Potash	**10 per cent.**

Nitrate of Soda	400 lbs.
Acid Phosphate (16 per cent. available Phosphoric Acid)	1200 lbs.
Sulfate of Potash	400 lbs.
	2000 lbs.

†NOTE – Bone Meal varies in composition. In this formula credit is given for 4 per cent Nitrogen and 8 per cent Phosphoric Acid available during the first year.

For Bearing Trees

Nitrogen	**2 per cent.**
Phosphoric Acid	**9 per cent.**
Potash	**11 per cent.**

Nitrate of Soda	240 lbs.
Acid Phosphate (16 per cent.) available Phosphoric Acid.	800 lbs.
†Steamed Bone Meal	520 lbs.
Sulfate of Potash	440 lbs.
	2000 lbs.

Vegetables, Potatoes, Roots, etc.

Nitrogen	**3 per cent.**
Phosphoric Acid	**8 per cent.**
Potash	**11 per cent.**

Nitrate of Soda	400 lbs.
Acid Phosphate (16% Avail.)	1000 lbs.
Sulfate of Potash	440 lbs.
Filler*	160 lbs.
	2000 lbs.

For Corn, Alfalfa, Clover

Nitrogen	**2 per cent.**
Phosphoric Acid	**8 per cent.**
Potash	**10 per cent.**

Nitrate of Soda	120 lbs.
Dried Blood (12% Nitrogen)	180 lbs.
Acid Phosphate (16% Avail.)	1000 lbs.
Muriate of Potash	400 lbs.
Filler*	300 lbs.
	2000 lbs.

This is a good general purpose fertilizer.

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*NOTE – Filler is unnecessary but may be used if it is desired to keep fertilizer in bags after mixing. If omitted, each of the plant food percentages is increased by about eight per cent. It is evident that with 160 lbs. of filler to the ton, only 92 per cent as much fertilizer would be required without the filler as with it. With 300 lbs. to ton, only 85% as much.

†NOTE – Calculated on basis of 1 per cent Nitrogen and 10 per cent. Available Phosphoric Acid.

For Wheat and Small Grain

Nitrogen	**1½**	**per cent.**
Avail. Phos. Acid	**10**	**per cent.**
Actual Potash	**8**	**per cent.**

†Bone Meal	780 lbs.
Acid Phosphate (16% Avail.)	900 lbs.
Muriate of Potash	320 lbs.
	2000 lbs.

DESCRIPTION OF FERTILIZER MATERIALS

Materials for Supplying Potash

Muriate of Potash contains 50 per cent. of actual potash and is one of the most concentrated of plant food materials. As a rule, a pound of potash costs less in the form of muriate than in any other form of potash and for this reason it is the most popular source of potash in mixed fertilizers or for home mixing. Muriate of potash is not generally used, however, on white potatoes, tobacco or citrus fruits.

Sulfate of Potash is recommended for citrus fruits, white potatoes and tobacco. It may be used upon all crops for which muriate of potash is recommended, and it is sometimes preferred for deciduous as well as citrus fruits. It occurs as a fine dry powder, and is readily adapted for mixing with other fertilizer materials. Sulfate of Potash usually contains 50 per cent. actual potash and is sold under a minimum guarantee of 48 per cent. actual potash.

Kainit is a crude salt; that is, it has not been refined or manufactured other than being ground into a condition ready for application as a fertilizer. It is sold under a

†NOTE – Bone Meal varies in composition. In this formula credit is given for 4 per cent. Nitrogen and 8 per cent. Phosphoric Acid available during the first year.

guarantee of 12.4 actual potash and contains potash, both in the forms of sulfate and muriate. It contains salts of magnesia and also common salt. Kainit can be used upon the crops for which muriate of potash is recommended.

Materials Furnishing Phosphoric Acid.

Materials furnishing phosphoric acid in a highly available form are acid phosphate, dissolved bone and dissolved bone black.

Phosphoric acid in a less readily available form, is to be had in bone meal and Thomas phosphate or basic slag. The amount which is available will depend to a great extent, upon how finely the material is ground.

Ground bone meal contains, as a rule, from 25 to 28 per cent. of total phosphoric acid of which 6 to 8 per cent. may be considered available during the first year. It also contains from 1 to 4 per cent. nitrogen. Dissolved bone, acid phosphate and dissolved bone black usually contain from 14 to 17 per cent. available phosphoric acid.

Materials Furnishing Nitrogen

The principal commercial sources of nitrogen are nitrate of soda, supplying from 15 to 16 per cent of nitrogen: sulfate of ammonia, 19 to 20 per cent. nitrogen, and dried blood from 10 to 14 per cent according to the grade. Tankage, in addition to supplying from 7 to 9 per cent. nitrogen usually contains about an equal amount of phosphoric acid. Of many other sources of nitrogen somewhat less in general use, we will mention dried fish scrap, containing from 7 to 9 per cent. nitrogen and 5½ to 7 per cent. phosphoric acid, and cotton seed meal, containing 6½ to 7 per cent. nitrogen and a small amount of phosphoric acid and potash.

Materials supplying nitrogen should be selected according to their relative availability, so that the plant may have a full supply during the growing season. Nitrate of soda probably furnishes nitrogen in the most available form. Sulfate of ammonia is more slowly available but much more readily available than dried blood, tankage or biproducts of the slaughter house.

The interests of the farmer are best conserved by an intelligent interest on his part, in the composition of the fertilizers which he uses. Valuable suggestions have been given about good general purpose formulas and how to make them. It is possible however, with a better knowledge of the composition of the materials furnishing the elements, nitrogen phosphoric acid and potash, to compound fertilizers according to any desired formula. Since "experience is the best teacher," the farmer who will follow our suggestions pertaining to plot experiments will have an advantage over his neighbor who has not made practical tests with the plant food elements.

As a result of our own experience we are confident that if these experiments are carefully conducted, even though it may be shown that on some soils and for some crops one element may be more important than another, the need of an available supply of potash will be demonstrated, and when put to the test of profit in dollars and cents, the conclusion will be that "Potash Pays."